Outorgado: Edgar Dutra Zanotto

Programas de Inovação Tecnológica / CEPID - Centros de Pesquisa, Inovação e Difusão - Edital 2011 Processo FAPESP 2013/07793-6

Relatório científico do Projeto CEPID - Centros de Pesquisa, Inovação e Difusão, referente o período de 01/07/2015 a 30/06/2016

São Carlos
Julho 2016

Center for Research, Technology and Education in Vitreous Materials – CeRTEV
(www.certev.ufscar.br)
Director: Edgar Dutra Zanotto
Universidade Federal de São Carlos / Departamento de Engenharia de Materiais / Laboratório de Materiais Vítreos (lamav.weebly.com)

Edgar Dutra Zanotto – UFSCar: *Nucleation, crystal growth, crystallization, glass-ceramics & properties – Director*
http://lattes.cnpq.br/1055167132036400

Hellmut Eckert - USP, São Carlos: Glass *structure, NMR methods - Vice-diretor*
http://lattes.cnpq.br/7357691451348243

Eduardo Bellini Ferreira - USP, São Carlos: *Crystallization, sintering and glass-ceramics – Technology coordinator*
http://lattes.cnpq.br/7703580367293028

Ana Cândida Martins Rodrigues – UFSCar: *Electrical properties, ionic conducting glasses and glass-ceramics – Education and outreach coordinator*
http://lattes.cnpq.br/4499231813051400

José Fabián Schneider - USP, São Carlos: Glass **s***tructure, NMR methods - Pesquisador Principal*
http://lattes.cnpq.br/7617205350746681

Andrea Simone Stucchi de Camargo Alvarez Bernardez - USP, São Carlos: *Optical properties, luminescence - Pesquisador Principal*
http://lattes.cnpq.br/5990189383563490

Marcelo Nalin - UNESP, Araraquara: *Optical and chemical properties - Pesquisador Principal*
http://lattes.cnpq.br/3349586880746735

Oscar Peitl Filho – UFSCar: *Bioactive glasses and glass-ceramics - Pesquisador Associado*
http://lattes.cnpq.br/3007441705652783

José Pedro Rino – UFSCar: *Molecular dynamics simulations - Pesquisador Associado*
http://lattes.cnpq.br/6801067322823031

Claudio José Magon - USP, São Carlos: *EPR and ESR techniques, Pesquisador Associado*
http://lattes.cnpq.br/2717187327982497

José Pedro Donoso Gonzalez - USP, São Carlos: *EPR and ESR techniques, Pesquisador Associado*
http://lattes.cnpq.br/2717187327982497

Paulo Sergio Pizani - UFSCar: *Raman spectroscopy, Pesquisador Associado*
http://lattes.cnpq.br/1038437165007849

Valmor Roberto Mastelaro - USP, São Carlos: *Structure, EXFAS, XRD and laser crystallization - Pesquisador Associado*
http://lattes.cnpq.br/4361220072322558

Marcello Rubens Barsi Andreeta–UFSCar: *Laser crystallization, crystal growth techniques – Pesquisador Associado*
http://lattes.cnpq.br/7904227795652627

RESEARCH PROGRESS

1. OVERVIEW

The **Ce**nter of **R**esearch, **T**echnology, and **E**ducation in **V**itreous Materials (CeRTEV) comprises 14 principal investigators and their co-workers at the Federal University of São Carlos (UFSCar), the University of São Paulo (USP), (both located in São Carlos) and the State University of São Paulo (UNESP, Araraquara). The principal investigators heading these groups are experts in vitreous materials, their crystallization and in a wide range of structural and functional characterization techniques. They advise about 60 graduate students and post-docs engaging in glass and glass-ceramic research, and are embedded in a large Brazilian and international collaboration network. As part of the joint CeRTEV research agenda, these groups work together to develop new active glasses and glass-ceramics, presenting application-relevant functionalities such as high mechanical strength, electrical conductivity, biological, optical or catalytic activity, and/or combinations of these properties. The synthesis efforts, which use both classical design strategies based on glass synthesis and controlled annealing as well as modern sol-gel-based self-assembly methods, are combined with detailed fundamental studies aiming at an understanding of (a) how composition and microstructure control the structural and dynamical properties of glass-ceramics and (b) how the latter relate to macroscopic physical and functional properties.

The research agenda of CeRTEV is sub-divided into five core areas, dedicated to the five principal application fields of glasses and glass ceramics: (1) *structural reinforcement materials* for architecture and construction, armor, as well as dental restoration, (2) *bioactive glasses and glass-ceramics* for bone healing and growth, (3) *ion-conducting materials* for applications in modern energy technologies, (4) photonic *glasses and glass ceramics,* and (5) *catalytically active systems.* All these application areas benefit from fundamental research encompassing the development of general concepts regarding the structural description of glasses and the structural, kinetic and mechanistic aspects of the nucleation and crystal growth processes involved in the crystallization of glasses leading to glass-ceramics, as described in more detail below.

2. FUNDAMENTAL ASPECTS

2.1. FACTORS IMPACTING CRYSTALLIZATION FROM GLASS-FORMING LIQUIDS

Glass-ceramics are generally produced by controlled annealing bulk glasses according to optimized time/temperature programs, developed on the basis of theoretical predictions of the temperatures and magnitudes of the maximum nucleation, growth, and overall crystallization rates of glass-forming liquids. To this end we have conducted a theoretical study, based solely on the classical theories of nucleation and growth, without introducing additional assumptions, such as the Stokes-Einstein-Eyring equation, models for specific kinetic mechanisms of aggregation, a specification of the type of temperature dependence of the diffusion coefficient, or specific models for the computation of the driving force of crystallization and the work of critical cluster formation [1]. Such approximations are employed only for analytical estimates and to illustrate the general results. We could show that the magnitude of the maximum of the steady-state nucleation rate J_{max} decreases upon increasing the ratio $T_{max}^{(nucl)}/T_m$ where $T_{max}^{(nucl)}$ is temperature of the maximum steady-state nucleation rate and T_m is the melting or liquidus temperature. Similarly, the maximum growth rate, u_{max}, decreases with increasing values of the ratio $T_{max}^{(growth)}/T_m$. These concepts have been used to interpret several experimental results on the crystallization kinetics of glass-forming liquids [1].

In another study, we have analyzed the relationship between $T_{max}^{(nucl)}$ and the glass transition temperature (T_g) as a function of various system parameters such as fragility [2]. Calculated values are compared with experimental results for six stoichiometric oxide systems that are known to exhibit homogeneous nucleation. The theoretical results support the experimental observation that liquids having $T_{max}^{(nucl)} > T_g$ tend to exhibit homogeneous nucleation whereas only heterogeneous nucleation is observed in other systems [2].

The relevance of the concepts of fragility, m, of the liquid and of the reduced glass transition temperature, T_g/T_m for the understanding of crystal nucleation and growth in glass-forming liquids has been explored in more detail [3]. Based on the analysis of crystallization processes in glass-forming melts, we could show that classical fragility can be relevant for the understanding of the crystallization behavior only if several severe conditions are fulfilled that are rarely met. For this reason, we have introduced a new definition of liquid fragility, employing the reduced variable T_m/T and not restricting the computation of m to T_g, as done in the standard approach. Moreover, the fragility index was specified by computing it for the temperature appropriate for the particular kinetic

process being analyzed. With this modified definition of fragility applied to both the diffusion coefficient controlling crystallization and viscosity, fragility becomes one of the main factors determining the temperatures and magnitudes of the maxima of nucleation, growth, and overall crystallization rates [3].

Finally, the effect of the breakdown of the Stokes-Einstein-Eyring equation on crystal growth processes has been analyzed [4]. This breakdown reflects a decoupling of the local translational and rotational motions, resulting in diffusion coefficients that are much larger than those calculated from the viscosities. We have formulated a new criterion by means of which one can determine, exclusively from experimental data, whether and at which temperature decoupling of diffusion and viscosity occurs in a given system. This decoupling temperature can be correlated with the glass transition temperature, and the fragility of the liquid. Based on classical nucleation theory a set of equations for determining the temperatures and magnitudes of the maximum nucleation, growth, and overall crystallization rates of glass-forming liquids has been derived and analyzed [4].

For a variety of oxide glass-forming liquids, the thermodynamic barrier for homogeneous crystal nucleation, W_c, exhibits an unusual increase with a decrease in temperature below the maximum nucleation rate. Such behavior differs from the predictions made using the classical nucleation theory. In principle, this behavior can be caused by internal elastic stresses that arise due to density misfits between the crystal and liquid phases. This contribution to W_c is usually neglected when analyzing experimental data in terms of classical nucleation theory. We have estimated the effect of the elastic strain energy term on the work required to form a critical nucleus for two glass systems with substantially different density misfits [5]. While the misfit in the lithium disilicate glass is significant, it is nearly zero for barium disilicate glass. Despite this difference, both glasses show anomalously increased nucleation barriers experimentally. Overall, these results show that elastic stresses do indeed reduce the thermodynamic driving force for crystallization, and thus increase the barrier to nucleation. However, the sole effect of elastic strain energy cannot explain the aforementioned unusual behavior of the thermodynamic barrier. Hence, a comprehensive explanation to this phenomenon still remains an open issue [5].

2.2. NEW EXPERIMENTAL CHARACTERIZATION METHODS

A simple and accurate technique has been devised for determining the crystal growth rate, U(T), over a fairly wide temperature range by means of a single differential scanning calorimetry run [6]. This method is based on using 50-200 μm-thick samples with parallel rough surfaces so that crystal growth is effectively unidirectional and the crystallization fronts have a constant area during the

entire crystallization process. Growth rates are calculated from the expression $U(T) = L \cdot q \cdot DSC(T)/A_{peak}$, where DSC(T) is the value of the differential scanning calorimetry (DSC) crystallization curve at each temperature T, A_{peak} is the overall peak area, L is half the sample thickness, and q is the heating rate. This method has been tested for different values of L and q for three glasses undergoing predominantly surface nucleation that possess distinctly different crystallization behaviors: stoichiometric lithium disilicate and diopside ($CaO \cdot MgO \cdot 2SiO_2$) and a nonstoichiometric lithium-calcium metasilicate. Growth rates spanning temperature intervals of more than 100 K, including temperature ranges where literature data are scarce due to experimental difficulties, were determined using a single DSC run. T. The growth rates determined using the proposed method show excellent agreement with published data determined by optical microscopy [6].

The structural relaxation kinetics of a silver meta-phosphate glass ($AgPO_3$) is investigated using a method based on the isothermal variation of its ionic conductivity over time [7]. Samples of $AgPO_3$ glass from the same batch were pre-annealed at 433 K or 418 K and then relaxed at different temperatures within this temperature range, which is close to its glass transition temperature measured by differential scanning calorimetry, T_g^{DSC} = 438 K. Ionic conductivity data were continuously collected by impedance spectroscopy during the isothermal relaxation process. The variation of the electrical conductivity over time is well described by the Kohlrausch expression ($\Phi(t) = \exp [- (t/\tau_\sigma^K)^\beta]$), in which τ_σ^K is the characteristic relaxation time and β a stretch exponent. Different values of β were found when the glass structure expanded or contracted during relaxation. In addition, viscosity values calculated by the Maxwell relationship using $< \tau >$ from conductivity data and a shear modulus taken from the literature are in accordance with the experimental viscosity measured in the same temperature range, thus validating the use of ionic conductivity to unveil glass structural relaxation [7].

New experimental methods were further refined in the area of structural characterization by NMR methods. The Double-quantum DRENAR method (**D**ipolar **R**ecoupling **E**ffects **N**uclear **A**lignment **R**eduction), a new technique invented by CeRTEV members for selectively measuring the strength of homonuclear magnetic dipole-dipole interactions (see Annual Report 2014), has been developed further and different variants for excitation and detection have been validated with the help of crystalline model compound studies [8,9]. The first applications to glasses and glass-ceramics have been summarized in a short review [10]. In particular, the method is well-suited for characterizing the spatial distribution of phosphate species in glasses containing small amounts of phosphate ions. It has been used to monitor the formation of lithium disilicate glass ceramics from non-stoichiometric glass compositions containing small amounts of phosphate ions. The data show the successive extent

of phosphate clustering at distinct annealing stages, ultimately resulting in the co-crystallization of lithium orthophosphate [10]. Based on these results, the method appears very promising to uncover differences in the spatial phosphate distribution between various types of bioactive glasses (normally containing only a few percent of phosphate); furthermore, dissolution and re-precipitation processes of the phosphate component upon the interaction with simulated body fluids can be monitored and evaluated. A new review article has been published summarizing the most recent progress on advanced solid state NMR spectroscopic methods and their application to glasses and glass ceramics [11].

Finally, new two- and three-body potentials have been developed, enabling molecular dynamics simulations of barium disilicate melts, yielding very promising results: the interaction potentials developed and subsequently used to simulate the structure of barium disilicate glasses yield excellent agreement with neutron diffraction structure factors and the vibrational density of states of this material [12]. The latter in fact matches very closely the simulated vibrational density of crystalline barium disilicate (sanbornite) and produces an excellent match to the phonon spectrum measured from Raman spectroscopy. These results are in good agreement with a previously stated hypothesis that seems to be applicable for all homogeneously nucleating glasses known to date: the local structures of the glass and that of the compound that crystallizes from it closely correspond to each other [13].

3. BIOACTIVE GLASSES AND CERAMICS

3.1. FUNCTIONAL ASSESSMENT AND NEW APPLICATIONS FOR BIOSILICATE

In a comprehensive review, we have analyzed work from 28 Master theses and PhD dissertations and over 30 scientific papers that tested Biosilicate®, a highly bioactive glass-ceramic developed at LaMaV, in a number of applications throughout the past 20 years [14]. Biosilicate® presents a combination of positive features for bone tissue regeneration: it is highly bioactive, osteoconductive, osteoinductive, non-cytotoxic, non-genotoxic and has antibacterial properties. In addition, in the monolithic form, it is quite strong and tough. Its in-vitro bioactivity is similar to that of the gold standard Bioglass 45S5. Biosilicate® has shown to be a very versatile, multipurpose biomaterial. It can be applied in powder, monolithic and 3D scaffold forms that could be easily machined during surgical procedures. This material has been successfully tested in a number of *in vitro, in vivo* and clinical studies, and several trials are ongoing [14].

During the review period, new applications of related bioactive glasses have been explored. Aligned bioactive glass microfibers in the SiO_2-Na_2O-K_2O-MgO-CaO-P_2O_5 composition diagram were incorporated into nanofibrous poly ε-caprolactone (PCL) membranes with the goal of developing a new biocomposite that is potentially able to facilitate nerve growth and increase the polymer matrix's biological and mechanical properties [15]. For the manufacture of this novel tubular nerve guide, electrospinning of PCL was performed on the surface of bioactive glass fibers, resulting in a two-layer microcomposite. The mechanical strength, bioactivity, wettability, degradation, and permeability of this new material were characterized. The preliminary results indicate that the incorporation of the bioactive glass fibers into PCL produces a highly bioactive composite with significantly improved mechanical properties and wettability compared with the PCL matrix alone. In another study, bioactive glasses have been studied for remediating tooth sensitivity following dental bleaching [16].

3.2. NEW FORMULATIONS, STRUCTURAL STUDIES, AND FUNCTIONAL CHARACTERIZATION

Doping bioactive glasses with alumina constitutes a strategy for increasing their mechanical strength. However, previous experiments on melt-cooled bioactive glasses had shown that Al doping proves detrimental to the bioactivity. In collaboration with the group of Professor Dominik Eder (University of Vienna) we could show that this drawback can be overcome by going to mesoporous systems [17]. Al-doped bioactive glasses (0.5 to 15 mole % Al_2O_3) with composition 80% SiO_2 - 15% CaO - 5% P_2O_5 (in mol %) were prepared by templated directed sol-gel synthesis, using the structure directing agent (P-123) for the formation of mesopores. While incorporation of Al_2O_3 reduces the order of the mesostructure, its specific surface areas, pore volumes and pore diameters decrease only slightly. *In vitro* bioactivity measured by release studies in simulated body fluid drops sharply only at alumina concentrations beyond 3 mole %. This can be related to strong interactions between $Al3^+$ and PO_4^{3-} ions, which could be proven by multinuclear single and double resonance solid state nuclear magnetic resonance (NMR) spectroscopy. The number of P-O-Al linkages was estimated by ^{27}Al (^{31}P) rotational echo double resonance (REDOR) experiments. The interaction of Al^{3+} and PO_4^{3-} and the trapping of Ca^{2+} required for charge compensation hamper the release of P, Ca and Si ions and thus provide less PO_4^{3-} and Ca^{2+} ions for the crucial formation of hydroxycarbonate apatite (HCA).

In another study, 10 mol% ZrO_2 was added to a 27CaO-5P_2O_5-68SiO_2 (mole %) base composition synthesized via a simple sol-gel method. This composition is similar to that of a frequently

investigated bioactive gel-glass. The effects of ZrO_2 on the *in vitro* bioactivity and MG-63 cell proliferation of the glass and its derivative polycrystalline (glass-ceramic) powder were investigated [18]. Upon heat treatment at 1000°C, the glass powder crystallizes into an apatite-wollastonite-zirconia glass-ceramic powder. Addition of ZrO_2 to the base glass composition decreases the rate of HCA formation *in vitro* and hence, ZrO_2 can be employed to control the rate of apatite formation. Tests with a cultured human osteoblast-like MG-63 cells reveal that the glass and glass-ceramic materials stimulated cell proliferation, indicating that they are biocompatible and are not cytotoxic in vitro. Moreover, zirconia clearly increases osteoblast proliferation over that of the Zr-free samples. This increase is likely associated with the lower solubility of these samples and, consequently, a smaller variation in the media pH. Despite the low solubility of these materials, bioactivity is maintained, indicating that these glassy and polycrystalline powders are potential candidates for bone graft substitutes and bone cements with the special feature of radiopacity.

The incorporation of ZrO_2 was also explored in apatite-forming glass compositions. Sol-gel glasses of the system $61.2SiO_2$-(24.3-x) CaO-$4.5P_2O_5$-$10ZrO_2$-xK_2O (x=0, 2, 4, 6mol%=Ca) were prepared and their crystallization and sintering into dense glass ceramics was optimized for in vitro bioactivity studies [19]. ZrO_2 addition improves the mechanical properties (three-point bending strength, Vickers microhardness, and fracture toughness) without compromising bioactivity, leading to hydroxycarbonate apatite (HCA) formation after 24h in SBF. In contrast, K_2O addition – while strongly improving the material's sinterability – decreases the bioactivity significantly. The favorable effect of ZrO_2 upon the mechanical properties is attributed to crack deflection by homogeneously dispersed ZrO_2 crystals (as evidenced by SEM) and the presence of Zr^{4+} ions in the residual glass network. Some potential applications, such as bioactive scaffolds, are suggested.

Gallium-containing bioactive glasses are of interest because of their potential antibacterial activity. We have used the sol-gel method to prepare a set of new mesoporous silica-gallium phosphate glasses along the composition line, $xGaPO_4$-(1 - x) SiO_2 (x = 0.5, 0.33, 0.20, 0.14, and 0.11) [20]. This glass-forming range is significantly wider than that accessible by melt quenching routes. The glasses exhibit a mesoporous structure with surface areas around400 m^2/g after calcination at 650 °C. NMR results indicate that the glasses consist of $GaPO_4$ and SiO_2 nanodomains. With increasing $GaPO_4$ content, the sizes of the $GaPO_4$ domains become larger. Evidence for the connection of both domains at their interfaces by P-O-Si and Ga-O-Si linkages is presented by advanced ^{71}Ga, ^{31}P, and ^{29}Si high-resolution dipolar solid-state NMR methods. The results reveal that the nanodomains of these glasses are significantly smaller than in the related $xAlPO_4$-(1 - x) SiO_2 system, which exhibits significant phase separation.

4. GLASSES AND GLASS-CERAMICS FOR APPLICATIONS IN MODERN ENERGY TECHNOLOGIES

Ion conducting glass-ceramics have shown significant promise for applications as solid electrolytes in high energy storage devices. The highest lithium ion mobility in the solid state is generally encountered in crystalline compounds with highly disordered cation sub-lattices, termed *superionic crystals*. Nevertheless, ion conducting glasses have the advantage of not suffering from grain boundary effects and hence form more homogeneous interfaces with the anode and cathode compartments of a solid state electrochemical cell. Thus, dense glass ceramics based on the crystallization of suitable precursor glasses offer the promise of combining both favorable features. The lead material in this area are based on glass ceramics crystallizing in the NASICON (**Na** **S**uper**I**onic **Con**ductor) lattice, which have already attracted commercial interest as membrane separators in lithium/air batteries. The CeRTEV research agenda focuses on the further development of such systems, based on a solid understanding of composition – structure – performance relationships. In addition, fundamental research conducted in this CeRTEV sub-area is aimed at the understanding of non-linear composition/function relationships in mixed network former glasses.

4.1. GLASS-CERAMICS BASED ON THE NASICON STRUCTURE

These systems are based on the $LiTi_2(PO_4)_3$ composition, and their ionic conductivity can be enhanced further by aliovalent ion substitutions, e.g. Al^{3+} on Ti^{4+} and/or Si^{4+} or Ge^{4+} on P^{5+} sites, resulting in rather complex compositions denoted as $Li_{1+x+y}Ti_{2-x}Al_xSi_yP_{3-y}O_{12}$ (LATP). An enhancement of the electrical conductivity is observable in both the Ge -> Al+Li and the P -> Si+Li substitution systems. During the review period CeRTEV's efforts in this area have aimed at (1) enhancing ion transport properties by isovalently substituting the larger Sn atom on the Ge sites, thereby widening the gateway through which Li ions can transfer between different sites [21]. Single-phase glass ceramics having the composition $Li_{1+x}Ge_{2-y}Sn_yAl_x(PO_4)_3$ system were successfully prepared within the composition field $x,y \leq 0.5$, and the intended lattice expansion and electrical conductivity enhancement were indeed realized. The random distribution of Sn and Al over the Ge lattice sites was confirmed by solid state NMR spectroscopy. For longer term sustainability of solid-electrolyte based energy technology, the development of sodium-based (rather than lithium-based) battery components is desirable owing to the much larger natural abundance of the element sodium. In currently on-going work we are therefore exploring the phase relations and ionic

conductivity/structure relations of analogous sodium-based NASICON glass ceramics. Successful preparation of single-phase crystalline compounds with additional incorporation of Li^+ ions was accomplished both through aliovalent Ge -> Al cationic substitution and through aliovalent PO_4^{3-} -> SiO_4^{4-} anionic substitution, Both approaches lead to significantly enhanced ionic conductivities which are comparable to those measured in the analogous lithium-based materials. Detailed mechanistic ion transport investigations using advanced two-dimensional NMR spectroscopy are in progress.

4.2. COMPOSITION- STRUCTURE- PROPERTY RELATIONS IN ION-CONDUCTING GLASSES

A general approach in tailoring the performance of glasses to specific applications is based on fine-tuning the chemical composition. When this general principle is applied to ion-conducting glasses one frequently encounters strikingly non-linear changes in physical properties (such as the glass transition temperature and the ionic conductivity). Network former mixing (NFM) can result in substantial increases (positive NFM effect) or decreases (negative NFM effect) upon ionic conductivities. For making optimal use of such effects in compositional design, a detailed structural understanding is sought on the basis of advanced solid-state NMR methods. Tellurium containing mixed networks are of interest, as their high electronic polarizability tends to promote ionic mobility and transport. A positive NFM effect upon glass transition temperatures and ionic conductivities is observed in the system $(Na_2O)_{0.33}[(2TeO_2)_x(P_2O_5)_{1-x}]_{0.67}$, within the composition range $0 < x < 0.5$ [22], whereas a negative NFM effect has been observed in $(Na_2O)_{0.33}[(2TeO_2)_x(B_2O_3)_{1-x}]_{0.67}$ glasses [23]. As described in the last research report, detailed solid state NMR studies have given detailed insights into the structural organization of these materials. While the phosphotellurite glass system is characterized by a clear preference for heteroatomic P-O-Te over P-O-P and Te-O-Te connectivity, the borotellurite system shows the exact opposite behavior. For the sodium borophosphate glass system, which also shows a very strong positive mixed network former effect, the relationship between this linkage preference and the ionic conductivity enhancement has been explained on the basis of new NMR results. Using $^{31}P\{^{23}Na\}$ and $^{11}B\{^{23}Na\}$ double resonance experiments, we could show that the negative charge in the macro-anionic network is dispersed over the non-bridging oxygen atoms of the (formally neutral) branching phosphate groups, whereas the (formally anionic) tetrahedral borate group are essentially not charged. This charge dispersal from borate towards phosphate is favored by the bond valence gradient within the hetero-atomic B-O-P linkages. As a result, the Coulombic traps attracting the mobile cations in the network are significantly more

shallow compared to the situation in alkali phosphate glasses, hence accounting for the observed conductivity enhancement [24]. A review of all currently available data observed for ion conducting multiple-network former oxide and chalcogenide glasses suggests that the above findings can be generalized: heteroatomic bond preference appears to be a general feature of glass systems exhibiting a positive network-former mixing effect, whereas systems tending towards phase separation (and thus preferences for homo-atomic linkages) generally exhibit negative network former mixing effects [25].

5. PHOTONIC GLASSES AND GLASS-CERAMICS

CeRTEV activities in this area have been characterized by three distinct efforts during the past year: 1) new glass and glass ceramic formulations doped with luminescent ions for laser applications, 2) development of new luminescent guest-host hybrid materials, and (3) mechanistic studies on glasses undergoing photothermal refractive and photo crystallization effects.

5.1. NEW FORMULATIONS FOR LUMINESCENT GLASSES AND GLASS-CERAMICS BASED ON HEAVY OXIDE METAL (HMOG) GLASSES

The design of high-efficiency luminescent glasses and glass ceramics for lasers in the near-infrared spectral region is at the core of the CeRTEV research agenda. These systems are based on luminescent rare-earth ions which must be well-dispersed within low-phonon environments to minimize vibrational de-excitation. During the review period we pursued the design of numerous heavy metal oxide glass frameworks with various different application foci. These studies include establishing procedures for preparing glasses stable against crystallization, characterizing their mechanical and thermodynamic properties and studying their photophysical behavior as a function of glass composition and doping level, including fundamental analyses of absorptive/emissive behavior within the framework of Judd-Ofelt theory. All of these efforts are accompanied by detailed structural studies, using vibrational (FTIR/Raman), nuclear magnetic resonance, and electron spin resonance spectroscopies, which provide insights both into the organization of the glassy framework and into the distribution and local bonding environments of the luminophores. Specifically, the following formulations were investigated:

a) Sm^{3+} doped glasses with composition B_2O_3-PbO-Bi_2O_3-GeO_2. These glasses feature intense green, orange, red and near infrared emission bands whose branching ratio was analyzed in detail [26].

b) Er^{3+} doped zinc tellurite glasses [27]. In this system the concentration dependence of the emission characteristics was investigated: with increasing Er^{3+} content the rate of red-to-green upconversion increases as a result of increased energy transfer efficiencies. Furthermore, self-trapping effects result in concentration dependent linewidths of the emission bands.

c) Eu-doped Sodium tungsten phosphate glasses, with potential for white light generation. The transparency of these glasses can be significantly improved by the addition of small quantities of Sb_2O_3 [28].

d) $SbPO_4$-based glasses containing heavy metal oxides [29] or GeO_2 [30]. The latter system was co-doped with Yb^{3+} and Er^{3+} and the doping ratio on the upconversion emission intensity was optimized.

e) Tb-doped heavy metal aluminophosphate glasses, investigating the effect of Tb^{3+} concentration on the branching ratio [31].

f) Glasses in the system PbP_2O_7-Nb_2O_5, which showed significant increases in the non-linear refractive indices as measured by the Z-Scan method. Procedures for preparing optical fibers based on these materials were developed [32].

5.2. INCORPORATION OF FLUORIDES INTO HMOGS: STRUCTURE-PROPERTY RELATIONS

In a following step, we studied the effect of alkaline earth and/or lead fluoride incorporation into HMOGs upon the optical and structural properties of these glasses and their crystallization behavior. For example, PbF_2 incorporation into Eu doped sodium tungsten phosphate glasses results in significant optical performance improvements, including higher quantum yields, longer excited-state lifetimes and blue shifted UV absorption edges [33]. The primary phases resulting from crystallization, lead apatite, $(Pb_5(PO_4)_3F$ and ß-PbF_2, are currently being explored for the preparation of rare-earth doped glass ceramics [34]. Similar work is currently being pursued in the lead borate based glasses such as the system PbO-GeO_2-B_2O_3-PbF_2.

The marked improvement of the emissive properties of fluorophosphate over phosphate glasses suggests that the fluoride ions dominate the local environment of the rare earth ions in these systems. To obtain more quantitative information in this regard, NMR and EPR studies were conducted on a glass system with compositions $25BaF_225SrF_2(30\text{-}x)Al(PO_3)_3xAlF_3(20\text{-}z)YF_3:zREF_3$ and

$25BaF_2 25SrF_2 (30-x)Al(PO_3)_3 xAlF_3 (20-z)ScF_3 : zREF_3$, where $10 \leq x \leq 25$, RE = Er^{3+} and/or Yb^{3+}, z = 0.25-5.0 mol% [35]. Echo-detected EPR spectra obtained on Yb^{3+} dopants indicate a mixed fluoride/phosphate ligand environment of the rare-earth ion, with a monotonically increasing contribution of fluoride with increasing fluoride content of the glass. These environments were characterized in more quantitative detail by NMR spectroscopy using the $^{45}Sc^{3+}$ ions as a diamagnetic mimic. Specifically, we measured the average strengths of the ^{45}Sc - ^{31}P and the ^{45}Sc - ^{19}F magnetic dipole-dipole couplings, resulting in a "count" of the average number of fluoride and phosphate ions in the rare-earth ion's first coordination sphere. The results from both NMR and EPR are well-correlated with excited state lifetimes and other photophysical parameters [36].

5.3. LUMINESCENT GUEST-HOST HYBRID MATERIALS

The study of the photoluminescent characteristics of host-guest systems based on highly emissive trivalent rare earth complexes such as Eu^{3+} - tris-bipyridine-carboxylate, immobilized in solid state host matrices, is motivated by their potential applications in optoelectronic devices and bioanalytical systems. Besides offering the possibility of designing a favorable environment to improve the photophysical properties of the guest molecules, encapsulation in porous solids also serves to protect such molecules, prevents leakage (especially critical for bio-applications) and ultimately leads to more robust and versatile materials. Among the most interesting possible host matrices are mesoporous silica and hybrids (organo-silicates) in the form of powders (MCM-41 like) and transparent bulk or film xerogels. Highly efficient red emitting materials based on the wet impregnation of such host matrices with the new complex Eu[4-(4′-tert-butyl-biphenyl-4-yl)-2,2′-bipyridine-6-carboxyl]$_3$ ("[^{t}Bu-COO]$_3$Eu") were prepared and characterized with respect to their structure, properties and photophysical behavior [37]. Incorporation and retention of the complex molecules are found to be significantly higher in the phenyl-modified hybrid samples than in the regular mesoporous silica, suggesting efficient immobilization of the complex by π-π interactions. Long excited state lifetimes (up to 1.7 ms comparable to 1.8 ms for the complex in solution), and high quantum yields (up to 65%, versus 85% for the complex in solution) were measured for the bulk xerogel materials, suggesting the potential use of thin films for lighting and bioanalytical applications.

5.4. MECHANISTIC STUDIES OF PHOTOTHERMAL REFRACTIVE GLASSES

Photo-thermo-refractive (PTR) glass is an optically transparent photosensitive sodium aluminum silicate glass, containing NaF and KBr additives, along with cerium, silver, tin and antimony oxide dopants. UV-exposed regions of this glass produce NaF nanocrystals upon heating, giving rise to a permanent, localized refractive index change. The initial photoionization process has been examined, for the first time, by continuous-wave and pulsed X-band electron paramagnetic resonance (EPR) spectroscopy [38]. UV exposure of PTR glass produces unpaired electrons whose EPR spectrum is characterized by pronounced peak splitting arising from magnetic hyperfine interactions with spin-5/2 and spin-7/2 nuclei suggesting close proximity of the unpaired electrons with ^{121}Sb and ^{123}Sb nuclei. These results indicate that the Sb_2O_3 dopant plays a key role in the initial stages of the crystallization mechanism. Upon thermal annealing, leading to the crystallization of NaF, these species disappear, indicating their transient nature. These results clearly challenge the classical mechanism proposed decades ago to explain the complex crystallization process of PTR glass. Together with more recent results from optical spectroscopy they support the recent model proposed by Nikonorov involving (1) photo ionization of Ce^{3+}, (2) transfer of this electron to Sb^{5+} species to create a Sb^{4+} species, (3) upon annealing electron transfer from Sb^{4+} to Ag^{+} ions, producing silver atoms, (4) coalescence of these species into Ag clusters, which (5) serve as nucleation catalysts for NaF nanocrystals [38]. The evolution of the UV-exposed materials into glass ceramics is currently studied in more detail using solid state nuclear magnetic resonance spectroscopy.

I. References (IAB members in red)

[1] Schmelzer, J.W.P., Abyzov, A.S., Fokin, V.M., Schick, C., **Zanotto, E.D**., J. Non-Cryst. Solids 429 (2015), 24-32
[2] Gupta, P.K.., Cassar, D.R., **Zanotto, E.D**. J. Non-Cryst. Solids 442 (2016), 34-39,
[3] Schmelzer, J. W. P.,Abyzov, A. S., Fokin, V.M., Schick, C., **Zanotto, E. D.;** J. Non-Cryst. Solids 429 (2015), 45-55.
[4] Schmelzer, J.W.P., Abyzov, A.S., Fokin, V.M., Schick, C., **Zanotto, E.D.** J. Non-Crystalline Solids 428 (2015) 68-74
[5] Abyzov, A.S, Fokin, V.M., Rodrigues, A.M.' **Zanotto, E.D**., Schmelzer, J.W.P., J. Non-Cryst. Solids
[6] Reis, R.M.C.V., Fokin, V.M., **Zanotto, E.D**., J. Am. Ceram. Soc.2016, in press.
[7] Bragatto, C.B.' Cassar, D.R., **Peitl,** O., Souquet, J.-L, **Rodrigues, A.C.M**. J. Non-Cryst. Solids 437 (2016) 43-47
[8] Ren, J.; **Eckert, H**. J. Magn. Reson. 260 (2015), 46-53
[9] Ren, J.; **Eckert H.** Solid State Nucl. Magn. Reson. 71 (2015), 11-18.
[10] Ren, J.; **Eckert H**. Solid State Nucl. Magn. Reson. 72 (2015), 140-147.
[11] **Eckert, H**. *Advanced NMR Spectroscopy of Glasses*, in "Modern Glass Characterization", M. Affatigato, ed., John Wiley and Sons 2015, 345-390 (2015).
[12] **Rino, J. P.; Pizani, P.S**.; **Zanotto, E.D**., to be published
[13] **Zanotto, E.D.**, Tsuchida, J.E., **Schneider, J. F**., **Eckert, H**. Intern. Mater. Rev. 60 (2015), 380-394.

[14] Crovace, M.C., Souza, M.T., Chinaglia, C.R., **Peitl, O., Zanotto, E.D.** J. Non-Cryst.Solids, 432 (2016), 90-110
[15] Souza, M.T., **Peitl, O., Zanotto, E.D.**, Boccaccini, A.R., Int. J. Appl. Glass Sci., 2016, in press.
[16] Melchers, S., Uesbeck, T., Winter, O., **Eckert, H**., Eder, D., Chem. Mater. 2016, in press.
[17] Montazerian, M., Yekta, B.E., Marghussian, V.K., Bellani, C.F., Siqueira, R.L., **Zanotto, E.D.,** Mater. Sci. Engin. C 55 (2015), 436-447
[18] Montazerian, M. **Schneider, J.F.**,Yekta, B.E.,Marghussian, V.K.' Rodrigues, A.M., **Zanotto, E.D**. Ceramics International 41 (2015), 11024-11045.
[19] Pintado-Palomino, K., **Peitl Filho, O., Zanotto, E.D.**, Tirapelli, C. J. Dentistry 43 (2015), 1099-1105.
[20] Ren, J., Doerenkamp, C., **Eckert, H**. J. Phys. Chem. C 120 (2016), 1758-1769 (2016).
[21] Santagneli, S., Baldacim, H., Ribeiro, S.J.L., Doerenkamp, C., **Eckert, H**., Kundu, S, **Rodrigues, A.C.M.**, J. Phys. Chem. C, submitted.
[22] Larink, D.; Rinke, M. T., **Eckert, H.,** J. Phys. Chem. C 119 (2015), 17539-17551.
[23] Larink, D.; **Eckert, H**. J. Non-Cryst. Solids 426 (2015), 150-158 (2015).
[24] Funke, L., **Eckert, H.,** J. Phys. Chem. C 120 (2016), 3196-3205
[25] **Eckert, H.** (invited review), In Diffusion Foundations, H. Mehrer, ed., TransTech. Publ. Vol. 6, 144-193 (2016).
[26] Herrera, A., Fernandes, R.G., **de Camargo, A.S.S.**' Hernandes, A.C., Buchner, S.Jacinto, C.Balzaretti, N.M., J.Lumin.171 (2016), 106-111
[27] Dousti, M.R., Amjad, R.J., Sahar, M.R., Zabidi, Z.M., Alias, A.N. **De Camargo, A.S.S.** J. Non-Cryst. Solids 429 (2015), 70-78.
[28] Dousti, M.R., Poirier, G.Y. **de Camargo, A.S.S.**, Opt. Mater.45 (2015), 185-190.
[29] Manzani, D.Montesso, M.' Mathias, C.F., Krishanaiah, K.V.' Ribeiro, S.J.L.' **Nalin, M**.' Opt. Mater. 57 (2016), 71-78.
[30] Manzani, R.S.' Donoso, J.P.' Magon, C.J.' Silva, I.D.A., Rüssel, C., **Nalin, M**., J. Braz. Chem. Soc.26 (2015) 2607-2614
[31] Kesavulu, C.R. Almeida Silva, A.C., Dousti, M.R., Dantas, N.O., **de Camargo, A.S.S**. Catunda, T. J. Lumin.165 (2015), 77-84
[32] Manzani, D., Gualberto, T., Almeida, J.M.P., Montesso, M., Mendonça, C.R., Rivera, V.A.G., De Boni, L., **Nalin, M**., Ribeiro, S.J.L., J. Non-Cryst. Solids 443 (2016), 82-90.
[33] Nardi, R.P.R.D., Braz, C.E., **de Camargo, A.S.S.**, Ribeiro, S.J.L., Rocha, L.A., Cassanjes, F.C., Poirier, G. Opt. Mater. 49 (2015), 249-254.
[34] Nardi, R.P.R.D., Braz, C.E., Pereira, C. Freschi, C.D., Ferrari, J.L., **de Camargo, A.S.S., Eckert, H.**, Cassanjes, F.C., Poirier, G. Materials Research 18 (2015) 218-23
[35] de Oliveira Junior, M.; Gonçalves, T. S.; Uesbeck, T.; **Magon, C. J.**, **Pizani, P.S.**; **de Camargo, A.S.S., Eckert,** J. Phys. Chem. C 119 (2015)., 24574−24587.
[36] de Oliveira Junior, M.; Gonçalves, T. S.; Ferrari, C. R.; Uesbeck, T.; **Magon, C. J.**; **Pizani, de Camargo, A.S.S., Eckert,** J. Phys. Chem. C 119 (2015), 24574−24587.
[37] Botelho, M.B.S., de Queiroz, T.B., **Eckert, H., de Camargo, A.S.S.** J. Luminesc. 170 (2016), 619-626.
[38] **Magon, C. J.; Donoso, J.P**. de Lima, F., **Eckert, H., Zanotto, E.D**., Lumeau, J., Glebova, L., Glebov, L. B., J. Non-Cryst. Solids, submitted.

6. INNOVATION AND TECH TRANSFER

Eduardo Bellini Ferreira – EESC/USP (Coordinator)
Edgar Dutra Zanotto – DEMa/UFSCar
Oscar Peitl – DEMa/UFSCar
Paulo Sérgio Pizani – DF/UFSCar
Sergio Luis da Silva – UFSCar (Tech Transfer Manager)

Summary of the tech-transfer plan

Overview of objectives and strategies

CeRTEV's research achievements are channeled into innovation, all the way from new technologies and patents, to new products and processes ("science to business approach"). Promising new technologies are expected in the main fields of the CeRTEV's agenda on the following application fields: 1) strong GCs for armors and dental implants, 2) bioactive materials for bone and tissue restoration, 3) energy storage and conversion systems, 4) photonic devices, and 5) catalysts for converting biomass into fuels and chemicals. In all these fields we vigorously pursue transferring fundamental and applied research activities to the productive sector.

Our strategy for technology transfer is based on three basic pillars: ***i) establishment of cooperation agreements and licensing of on-demand technologies commissioned by industry*** – the widespread skills of our group are in focus to bring the industry close to our academic institutions, connecting universities, companies and other institutions through cooperation programs as PITE and PPP/FAPESP, and FINEP; ***ii) nucleation of spin-off companies from the group activities*** – entrepreneurship is stimulated, encouraging engagement in programs such as PIPE/FAPESP; and ***iii) extensive promotion of innovation and technology transfer*** – accomplished by our extensive know-how in these subject areas combined with the assistance of agencies at UFSCar (www.inovacao.ufscar.br) and USP (www.inovacao.usp.br).

We aim at developing new or improved glass and glass-ceramics in each field of the applications mentioned above, e.g.: 1) light armors (for airplanes, cars and individuals) and tougher monolithic glass-ceramics for dental restoration; 2) macroporous and hierarchically ordered scaffolds, fibers, small monolithic parts and powders with increased osteoinductive activities, combined with the ability for targeted drug delivery for bone and tissue repair; 3) fast-conducting solid electrolytes for lithium ion batteries and new glass-ceramic seals for fuel cell applications; 4) solid state lasing materials with enhanced emission characteristics, and 5) an entirely novel application of macroporous and hierarchically structured glass-ceramics for conversion of biomass into fuel and

fine chemicals. Industrial partners will be approached in concert with the research advances made in each area.

The technological core of our group is working to establish infrastructure for the production of prototypes on a scale beyond the lab, bringing our activities as close as possible to the productive sector. For this purpose, we acquired one melting furnace to produce glass in larger amounts than in the lab scale (kilograms instead of grams) and one disc mill for higher throughput of glass powder. It is in progress the acquisition of a lab spray dryer for conditioning powders into granules with suitable properties for fine powder processing.

In view of our goal to ensure efficient cooperation between academia and industry, it is crucial to increase the exposure of our students and postdoctoral fellows to the R&D environment in the industrial sector, significantly beyond the current practice in national postgraduate programs. To this end, we planned to establish a new fellowship program with the explicit purpose of enabling students to conduct part of their master and doctoral projects in the laboratories of our industrial partners. The costs of these fellowships will be shared between both parties. When it is necessary, we will work on adjusting the current postgraduate rules at our home universities to facilitate the establishment of this program.

An agenda of specially designed workshops will be established to guide CeRTEV members and collaborators in responding to manifestations of interests from industries and in developing some of their research activities towards innovation, to follow the patent literature, to gain access to patents and market reports, to estimate production costs and to identify potential markets for a given technology, to avoid publications prior to patent filing, and other important issues. The relevant information will be systematized and made available in the CeRTEV homepage.

The discussion list in the Internet denominated "*Vidros*" was created in 1997 by E.B. Ferreira (Coordinator of Tech Transfer). Formerly, vidros@listas.ufscar.br was hosted at UFSCar's General Secretariat for Information (Sin). In the 2013-2014 period of CeRTEV activities it was brought to a more modern and attractive virtual environment, called"*listavidros*" at https://groups.google.com, e-mail address listavidros@googlegroups.com. Active people in the field of vitreous materials are invited to join and participate, stimulating the relations and R&D activities between academia and industry.

Finally, we aim to create an office to gather and make contact among CeRTEV's members, the glass industry and other institutes to access industrial problems and create demand for R&D in Brazil in traditional and new glass and glass-ceramic materials, including design, production and applications.

Overview of former achievements and last-year results

Establishment of cooperation agreements and licensing of on-demand technologies commissioned by industry

Several actions were taken to establish cooperation agreements and licensing of technologies commissioned by industry and/or developed by CeRTEV team. They were summarized below by one-year periods.

2013-2014

E.D. Zanotto (CeRTEV Coordinator) established Non-Disclosure Agreements (NDA) with the following companies with glass-based products, whose importance is measured worldwide: Ivoclar Vivadent (Liechtenstein), AGY (EUA), Owens-Illinois Glass (USA), and DMC (Brazil). Contracts for technology development were signed between members of CeRTEV team, UFSCar and the Aerospace Technical Center (CTA), a division of Brazilian Aeronautics, for "developing of glass-ceramic armors". H. Eckert (CeRTEV Vice-Coordinator) also established NDA with top glass companies: Schott (Germany), Corning (EUA), Nippon Electric Glass (Japan) and Ivoclar Vivadent.

E.D. Zanotto was consulted by an Italian company from Murano on the choice of São Carlos for a new manufacturing plant of the traditional artistic glass. The company considered installing a Murano glass factory, the first abroad, in the State of São Paulo, and São Carlos was a strong player due to its universities and facilities in the glass field. Unfortunately since then we have not heard further news about this project yet, probably due to the uncertainties related to the current economic scenario of the country.

E.B. Ferreira supervised a master project (Raúl Revelo Tobar) on "recycling glass from CRT monitors into glazes for ceramic tiles", developed in partnership with Ceramic Center of Brazil (CCB), which specializes in the characterization and specification of ceramic tiles under standard practices. This effort was a stepping stone in building up a relationship with industries of the Ceramic Tile Pole of Santa Gertrudes (about 70 km from São Carlos), which is one of the largest of its kind worldwide. The project was completed in September 2014, and we are currently awaiting further requests for collaboration. As these industries command only rudimentary knowledge on glass technology, we expect a longer-than-usual induction period for establishing a partnership.

2014-2015

E.D. Zanotto had a new NDA signed with IVOCLAR for "dental glass-ceramics", and had approved a grant from Nippon Sheet Glass to study "which equation best describes the equilibrium viscosity of oxide glass-forming liquids". H. Eckert has on-going research collaborations with Corning on "more fundamental structural research by NMR, regarding the mixed glass formers effect", and Nippon Electric Glass on "structural parameters influencing the crack resistance of magnesium aluminum-borosilicate glasses".

New negotiations had started with other industrial companies: E.B. Ferreira started negotiation with Rhodia (Brazil) for "using biomass for the production of glass"; M. Nalin started negotiation with the Brazilian glass company Nadir Figueiredo for "the relationship between optical properties and process variables in the manufacture of glass"; and H. Eckert negotiates with the Brazilian glass company Electroglass for "a methodology for characterizing the structural origins of mechanical stability upon thermal shock".

2015-2016

E.D. Zanotto maintained negotiations for a partnership agreement with Owens-Illinois Glass (USA), the largest glass bottle producer in the world with ~80 plants (5 in Brazil). That project has not materialized YET due to complicating issues regarding IP. He is also made a partnership with saxon glass (usa) regarding tech transfer on efficient methods of chemical strengthning of glass.H. Eckert has a NDA signed with Nippon Electric Glass and has in progress a joint research project with the same company, concerning the characterization of scratch resistant glasses, and with Corning Glass Inc. for "characterization of silicon boro phosphate glasses". E.B. Ferreira has a NDA signed with Rhodia (Brazil) and started a 6-month cooperation agreement to conduct analyzes for "use of biomass for the production of glass". M. Nalin has a NDA signed with SGD Brazil, a Brazilian glass company producer of containers for perfumery & cosmetic and pharmaceutical industry, and started a 2-year research partnership agreement with the same company. M. Andreeta maintained negotiations for a partnership agreement with Alacer Biomedical for "development of pH sensors". A.C.M. Rodrigues performed technical services "G*lass defect analysis by scanning electron microscopy*" and "*Scratch analysis on opaline plates by scanning electron microscopy*" commissioned by the Brazilian glass company Nadir Figueiredo. And, finally, S.L. Silva (Tech Transfer Manager) maintained negotiations and conducted technical visits to the Brazilian company InFibra that manufactures articles based on fiber cement, with the aim of establishing cooperation in project management.

Further actions for the establishment of cooperation agreements will be considered in accordance with the research advances made in each area.

Nucleation of spin-off companies from the group activities

In August 2014 the first spin-off company from CeRTEV, VETRA High-Tech Ceramic Products was established in São Carlos by three CERTEV researchers, based on their doctoral and post-doctoral research achievements. This micro enterprise aims to offer solutions for different market segments by developing glass and GC materials that combine unique features such as biodegradability, bioactivity and bactericidal properties for bio applications.

In 2015-2016 VETRA was licensed by UFSCar (as Titular) via the University Innovation Agency to explore two patents resulting from CeRTEV's research efforts: BR 10 2013 020961 9 and BR 10 2014 003817 5 (detailed below). As part of the strategy to turn such efforts into innovation, the first patent above was extended to USA (US14/911,444) and Europe (FU140801PEP) through a Patent Cooperation Treaty (PCT) application (PCT: BR2014/000275) supported by part of the CeRTEV budget to Tech-Transfer, which has disbursed R$ 41.031,13 in April/2016 for this purpose. The second patent is being analyzed for a Patent Cooperation Treaty (PCT) application as well. As part of the same strategy, a project of **Innovative Research in Small Business** (PIPE/ FAPESP) was elaborated in collaboration with VECTRA and submitted to FAPESP in 2016, having E.D. Zanotto as supervisor at university.

Extensive promotion of innovation and technology transfer

Patents filed in the Brazilian National Institute of Industrial Property (INPI)

The following patents and other intellectual properties were filed in the Brazilian National Institute of Industrial Property (INPI) by some of CeRTEV researchers, as solid results of their scientific and technological efforts in the main fields of interest of our CEPID.

2013-2014

- BR 10 2013 017769 5 "*Glass-ceramic compositions, obtained glass-ceramic from the same, armor of sacrifice, and ballistic protection armor*" (in Portuguese), Titular UFSCar, Inventors L. Sant'Ana Gallo, A.C.M. Rodrigues, O. Peitl and E.D. Zanotto, June 26, 2013.

- BR 10 2013 020961 9 (PCT: BR2014/000275) "*Glass composition, fiber and bioactive vitreous fabrics obtained from the same, and articles obtained by the same*" (in Portuguese), Titular UFSCar, Inventors E.D. Zanotto, M.T. Souza and O. Peitl, August 12, 2013.

- BR 10 2014 003817 5 "*Discontinuous coating process using a bioabsorbable and bioactive biomaterial applied to solid substrates, the discontinuous coating obtained by same and the use of the discontinuous coating obtained by same*" (in Portuguese), Titular UFSCar, Inventors E.D. Zanotto, C.R. Chinaglia and O. Peitl, February 19, 2014.

2014-2015

- BR 10 2014 032548 4 "*Tubular conduit based on bioactive and bioresorbable glass fibers for regeneration of peripheral nerve tissue and process of obtaining the same*" (in Portuguese); Titular: UFSCar; Inventors: E.D. Zanotto, M.T. Souza, O. Peitl, December 23, 2014.

- BR 10 2014 023349 0 "*Device and method for obtaining fibers by downdrawing of compositions with low glass stability*" (in Portuguese); Titular: UFSCar; Inventors: E.D. Zanotto, M.T. Souza, O. Peitl, September 19, 2014.

2015-2016

- BR 51 2015 001136 7 Model, software "Reformix 3.0." (in Portuguese); Titular: UFSCar; Inventors: E.D. Zanotto, H.B. Guarnieri, L.F. Bocanegra, V.J.C. Godoy, October 07, 2015.

- BR 51 2015 001499 4 software "GLASSPANACEA" (in Portuguese); Titular: UFSCar; Inventors: E.D. Zanotto, O Peitl, R.L. Siqueira, J.H. Alano, November 23, 2015.

- BR 10 2016 002224 0 "Biomimetic composites comprising high filler content based on chitosan and bioceramic, process for preparing the same and the use of said composites in tissue engineering" (in Portuguese), Titular: UFSCar; Inventors: E.D. Zanotto, O Peitl, L.R. Santos, R.L. Siqueira, S.M. Malmonge, J.K.M.B. Daguano, January 02, 2016.

- BR 10 2016 008683 3 "Conductive materials for sodium ion, preparation route and sodium ion battery" (in Portuguese), Titular: UFSCar; Inventors: A.C.M. Rodrigues, J.F.O. Mosquera, A.M.N. Muñoz, April 19, 2016.

- Extension to USA (US14/911,444) and Europe (FU140801PEP) of the patent BR 10 2013 020961 9 (PCT: BR2014/000275) "*Glass composition, fiber and bioactive vitreous fabrics obtained from the same, and articles obtained by the same*" (in Portuguese), Titular UFSCar, Inventors E.D. Zanotto, M.T. Souza and O. Peitl, August 12, 2013.

- In progress: "Inert and bioactive implants for human anophthalmic cavity" (in Portuguese) Inventors: O. Peitl & E.D. Zanotto (UFSCar), and S.A. Schellini & S.M. Brandão (FMB/ UNESP).

These patents are being analyzed at INPI, which may take from 7 to 10 years. Some of them are also being analyzed by the UFSCar Innovation Agency for a Patent Cooperation Treaty (PCT) application.

Other actions for promotion of innovation and technology transfer

2013-2014

- August 13, 2013: a team of CeRTEV researchers attended a meeting with Eduardo Brito, Administrative Analyst, and Freid Artur, Innovation Agent at USP Agency for Innovation, during the 5th Week USP on Intellectual Property and Innovation. The following seminars were presented by E. Brito: (i) "*Legal Framework, Regulatory Framework and Incentives for Innovation*"; and (ii) "*University/Industry Partnership – Formalization, Benefits, Rights and Duties*". The presentations were accompanied by questions and answers on the specific demands of CeRTEV members.

- September 20, 2013: the Symposium "*The challenges of invention and innovation in Brazil: experiences of success and failure in the State of São Paulo*" was held at UFSCar São Carlos, sponsored by the Academy of Sciences of the State of Sao Paulo (Aciesp) and organized by E.D. Zanotto (Aciesp member and CeRTEV Coordinator). The speakers are recognized authorities in

product development, processes, patents, interaction with companies, research and management of science and technology. The Symposium discussed the process of invention and innovation in universities and companies, and especially the experiences conducted in the State of São Paulo. The event was open to students, teachers, researchers, entrepreneurs, journalists and the interested public. Media exposure, e.g.:

- http://agencia.fapesp.br/17876
- http://www.dci.com.br/sao-paulo/simposio-em-sao-carlos-discute-inovacao-id364282.html.

- The discussion list in the Internet "*Vidros*" was brought to a more modern and attractive virtual environment, and denominated now "*listavidros*" at https://groups.google.com. Active people in the glass field are invited to join and participate, stimulating the -relationship and R&D activities between academia and industry. The list grew 60% up to 160 academic and industrial participants.
- April 2014: E.D. Zanotto received the award "Pawn of Technology" from the Technological Park Foundation of São Carlos (ParqTec). Since 1993 the title is awarded to people who have contributed through technological innovation to increase production, quality and competitiveness of products, processes and services in companies. Media exposure was wide, for example:
  - http://agencia.fapesp.br/19052
  - http://sbpmat.org.br/professor-edgar-zanotto-recebe-o-titulo-de-peao-da-tecnologia-por-suas-acoes-em-prol-do-desenvolvimento-de-sao-carlos/
  - http://www.abc.org.br/article.php3?id_article=3330
  - http://sinc.com.br/pesquisadores-de-sao-carlos-sp-recebem-titulo-de-peao-da-tecnologia.html
  - http://www.abividro.org.br/noticias/edgar-dutra-zanotto-recebe-o-titulo-de-peao-da-tecnologia.

2014-2015

- Write a Portuguese Book on Glass Technology was considered from the common sense that there is a big gap between industry and academy in the field of glasses in Brazil, as in many other technologies. The largest companies installed in the country are mostly multinational with their headquarters and R&D labs abroad. The activities in this country are mainly focused on production and commercialization, attracted by a colossal internal market and the relative low costs of raw materials, manpower and production, and much less on development of new technologies and intellectual properties. We can observe this "mismatch" between academia and industry even for companies with domestic capital, which look abroad for the technologies they demand, transferring to foreign countries the impact of their economic activities. This is true to an even larger extent in the field of high-tech glass-ceramics. After many years of experience on higher education of our CeRTEV team, we have clearly identified the current deficits of affordable technical information in

the field as one of the main barriers to break this vicious cycle of underdevelopment, which translates to a large extent in lack of specialized literature in Portuguese. For CeRTEV 2nd year, we planned start writing and make accessible in Portuguese a book on Glass Technology, targeting the workers in industry and students in the field as the main audience. We had identified several specialists on aspects of the glass production in Brazil, with solid experiences in the glass industry, willing to collaborate in this challenge. To this end, we rely on the important partnership with Dr. Mauro Akerman, who has 30 years of industrial experience at Saint Gobain Glass in Brazil as an internal consultant in the area of glass processing and management of technical training programs, now retired. Since 2008 M. Akerman has served as an independent consultant in the area; besides, he is coordinator of the School of Glass associated with ABIVDRO; and coordinator of the technical committee of ABIVIDRO. The project of a Portuguese Book on Glass Technology was, however, delayed in the last year due to the involvement of most people (mainly M. Akerman) in the project of the technical course on glass technology detailed in the Education and Outreach Section. The current state of this project is detailed in the section for 2015-2016, below.

- Meetings with industrial and laboratories partners: the project of a technical course on glass technology, well detailed in the Education and Outreach Section, has served as a powerful tool for approaching potential industrial partners. We pursued the following agenda of meetings and visits to production plants and labs: Cebrace (Jacareí) – glass float + coating (sputtering) lines, Pilkington (Caçapava) – thermally toughened and laminating lines of car Windows, Nadir Figueiredo (Itaquaquecetuba) – tableware production line, Verallia (São Paulo) – food packaging production line (bottles) and the glass laboratory of the Technical Center for Glass Elaboration (CETEV), Speedtemper (São Roque) – toughened and laminating lines of glass for building construction, UFSCar (São Carlos) – Materials Characterization and Development Center (CCDM) and Vitreous Materials Laboratory (LaMaV), CETEA/ITAL (Campinas) – packaging test laboratory, Atelier Pierre Frisch (Santa Isabel) – handmade glass, handcraft glassware, FATEC (São Paulo) – characterization of vitreous materials laboratory, Verallia (Porto Ferreira) – training center, Wheaton (São Bernardo do Campo) – production line of pharmaceutical and cosmetic bottles and operational training center, **ABIVIDRO (São Paulo) –** Brazilian Technical Association of Glass Automatic Industries.

- CeRTEV meeting with the International Advisory Board: E.B Ferreira presented the CeRTEV Technology Transfer Program for the International Advisory Board during the X Brazilian Symposium on Glass and Related Materials (X-BraSGlass), held in São Carlos from 26 to 30 October, 2014. The IAB Attendees were: Joe, H. Jain, L. Glebov, Dick, B. Aitken, S. Martin, J. Schmelzer, J. Deubener, C. Ruessel, W. Höland, Y. Yue, Jean-Luc Adam, Annie Pradel, T.

Komatsu, Shingo, Y. Messaddeq (Jeff). The main suggestions from the IAB members and related with Tech Transfer were listed below: 1) establish an industrial affiliate's network with an open to visitors day; 2) increase interaction with the "innovation offices" of the three Universities; 3) CeRTEV students should be motivated to start spin off companies; 4) work more closely with the CeRTEV manager of technology & innovation; 5) CeRTEV faculty and students should interact more with Brazilian industries, e.g.: catalytic supports, construction materials, armor materials and bio materials; 6) try to solve relevant Brazilian problems: establish how CeRTEV's activities or efforts are related with the local industry, not only traditionally related with glass, but also others where glass is not an issue at a first view (agriculture, food, nutrition, recycling, etc.); 7) make efforts to include more PhD into Brazilian industry; 8) clearly define mission statements; 8) advertise the CeRTEV students (its main product) to industry; 9) look not only into the glass industry, but also in the whole industrial chain for opportunities on glass technology; 10) Glasses in devices? Look for interesting problems related to applications of glasses (not only glass production); 11) provide characterization and testing services to industry; promote a spin-off company on glass characterization. Some of them already are topics of the CeRTEV Tech Transfer Program and are being accomplished, and others will be taken into account.

- 6th 3M Institute Award for University Students: the undergraduate student of Mechatronics Engineering Rubens Henrique de Carvalho Maria, supervised by E.B. Ferreira, CeRTEV Tech Transfer Coordinator, had his project of automatic machine to cut glass bottles and make sustainable glass cups (*Ecups*) qualified for the final round of the 6th 3M Institute for University Students Award: http://www.unisol.org.br/2015/06/veja-os-finalistas-do-6o-premio-instituto-3m-para-estudantes-universitarios/. He was one of the top 6, but unfortunately not won. Nevertheless, as the 6th 3M Institute Award for University Students had in 2015 a record of entries: 240 ideas submitted with the most diverse proposals and coming from all over the country, this was already a significant result (see below).

2015-2016

- 6th 3M Institute Award for University Students: see entry in the period 2014-2015 above. The final stage of the contest was held in July/2016 and the result was announced after. Media exposure was wide, for example:
  - http://www.eesc.usp.br/portaleesc/index.php?option=com_content&view=article&id=2444:trabalho-de-aluno-da-eesc-ficou-entre-os-finalistas-em-concurso-de-empreendedorismo&catid=115:geral&Itemid=164
  - http://g1.globo.com/sp/sao-carlos-regiao/noticia/2015/09/jovem-cria-maquina-que-reaproveita-garrafas-de-vidro-para-fabricar-copos.html

- http://www.abividro.org.br/noticias/universitario-cria-maquina-para-reaproveitar-garrafas-de-vidro-e-criar-copos
- http://www.jornaldocampus.usp.br/index.php/2015/09/um-novo-destino-as-garrafas-de-vidro/

- In 2015, the project "Green Cups, an alternative to add value to glass bottles in the Cooperative of Collectors of São Carlos (Coopervida)" (focused on promoting glass recycling), coordinated by E.B. Ferreira and developed by the student of mechatronic engineering at EESC Rubens Carvalho and other students, was selected for the final stage of the 18th Santander University Solidarity Award (only 16 projects were selected from 1378 applications!). Unfortunately, we did not make it into the 8 end winners.

- E.B. Ferreira organized the *I Workshop University-Industry on Glass Materials*, held at Engineering School of São Carlos, USP, in September 11, 2015, aiming at probing demands on glass science and technology from the national glass industry and other industries with interest on glass. The *Workshop* had 72 persons registered (32 from University and 40 from Industry), of which 52 were present (30 from University and 22 from Industry). Representatives of 17 different companies attended the meeting (15 sent delegates). The main result of this event was the suggestion of creation of a National Industrial Advisory Board (NIAB) for CeRTEV. Names of potential advisers from the Brazilian industry on glass and other interested parties have been listed in partnership with colleagues well familiar with the field, namely Dr. Mauro Akerman and Pierre Frisch, which will be invited for a meeting and launching of NIAB in the next year.

- The project of a Portuguese Book on Glass Technology has been discussed and we have considered it would be better if it could be made available online and at the time it was being written. Such format can make the glass content available faster and for a larger community than would a traditional printed book. An open collaboration platform was devised and named **Wikividros**. The website, still in construction, was hosted at https://wikividros.eesc.usp.br/. The website is being built in collaboration with technical staff of the Informatics Technical Section (STI-EESC) at USP through the software DokuWiki[1], a simple to use and highly versatile Open Source wiki software that does not require a database. A wiki[2] is a website that provides collaborative modification of its content and structure directly from the web browser. Currently, a request was made to the EESC board of directors for authorization for hosting the **Wikividro**s as a public website on the server computer of the EESC/USP, for which the announcement due out soon. Then the formation of the content on glasses to compose the website will be promoted initially among the members of CeRTEV and its partners.

[1] https://www.dokuwiki.org/dokuwiki#
[2] https://en.wikipedia.org/wiki/Wiki

- The properties and performance of catalysts glass-ceramics will be tested in collaboration with colleagues at the Brazilian Laboratory of Bioethanol Science and Technology (CTBE) and the Brazilian Laboratory of Synchrotron Light (LNLS). Recently the contact with CTBE people has been reestablished and a researcher expert in catalysis is being selected for a CeRTEV post-doctorate grant, for which a quota was already approved by FAPESP, to start in August 2016 and make the bridge between CeRTEV and CTBE.
- The development of equipment & scientific instrumentation devices is a very important activity from the CeRTEV researcher efforts. Such activities may in the future turn into innovation. We detected several such efforts by our researchers, listed below:
  - C. Magon (IFSC/USP) – EPR: has reformed a disposed spectrometer of electron paramagnetic resonance or electron spin resonance (EPR or ESR), a spectroscopic technique to detect species containing unpaired electrons, i.e., paramagnetic species.
  - M. Andreeta (LaMaV/UFSCar) – Laser Melting System: a new system for testing new vitreous compositions is being completed based on laser fusion. This system uses a CO_2 laser as heat source and does not need crucibles (contactless melting). The melting temperature is not limited as the system can reach temperatures above 3000 °C. By means of this equipment we will be able to produce and study novel compositions of glasses at high melting temperatures.
  - M. Andreeta (LaMaV/UFSCar) – System of laser micro-heaters: a system based on crystalline and glassy optical fiber doped with rare earths (Nd^{3+}) is being developed to produce punctual micro-heaters for medical use in thermotherapy and hyperthermia. The system is based on the use of optical fiber for guiding a laser beam centered at 808 nm, at whose end has a high concentration of rare earth. Multi-phonon relaxation occurs in the tip, generating localized heating.
  - M. Andreeta (LaMaV/UFSCar) – pH measuring devices: vitreous systems based on lanthanum and titanium silicates are being studied as solid state pH sensors. Such sensors can be produced in small dimensions and thus be applied, e.g., in medicine.
  - O Peitl & M. Trevelin (LaMaV/UFSCar) – Electrospinning system for fabrication of Peripheral Nerve Conduit made by a core of oriented microfibers of extremely bioactive glass and shell of absorbable polymer nanofiber.
  - E.B. Ferreira (EESC/USP) and C. Magon (IFSC/USP) – software and hardware based on Arduino for data recording: the system is being developed for use during sintering treatments aided by electric field of glass particle compacts. These compacts sinter at extremely fast rates, while the system can simultaneously record the voltage and electric current through the sample as well as the furnace temperature, and interrupt the electric *potential difference* in a controlled way at a given boundary condition.

- E.B. Ferreira & C. Fortulan (EESC/USP): a laboratory device for tape casting from ceramic slurries was built to form glass particle suspensions aiming at obtaining sintered glass-ceramic thin plates for applications in electronics and integrated systems with LTCC (Low-Temperature Co-fired Ceramics) technology.

7. TECHNOLOGY DEVELOPMENT AND TRANSFER- *Plan of New Activities for Year 4*

We will continue on the path traced in our CEPID proposal for the technology transfer strategy during the 3rd year (2015-2016) of CeRTEV. In summary, the concepts and activities are detailed below, together with a plan of new activities for the next year when they are fit.

Establishment of cooperation agreements and licensing of on-demand technologies commissioned by industry

Several agreements between the CeRTEV team and companies with interest in glass and glass-ceramic technologies have already been formalized, as stated in the Tech Transfer Section of this report. Others are currently being negotiated or are on the way to be formalized. For the fourth year, we plan to consolidate the transfer of technologies based on scientific and technological researches accomplished by our team, and further develop our partnerships with these companies. The corresponding results will be documented in the form of new prototypes and filed patents. Technology licensing will be always pursued as a result of the agreements mentioned above.

Nucleation of spin-off companies from the group activities:

This is, of course, the most challenging task. Nevertheless, the first spin-off company from CeRTEV, VETRA High-Tech Ceramic Products, was established in São Carlos in 2014. VETRA was licensed by UFSCar (as Titular) via the University Innovation Agency to explore two patents resulting from CeRTEV's research efforts. A project of **Innovative Research in Small Business** (PIPE/ FAPESP) was designed for this company under the supervision of E.D. Zanotto and submitted to FAPESP. They have not had a response yet. We will keep encouraging our researchers to pursue this kind of entrepreneurship.

Promotion of innovation and technology transfer:

We will continue our efforts to establish facilities for the production of prototypes, on a scale beyond the laboratory. As planned, one melting furnace for larger glass volumes than the conventional lab scale and one disc mill, which can be continuously operated for relatively large production of glass powders, have already been acquired by E.B. Ferreira at EESC/USP and started operating. A lab spray dryer for conditioning powders into granules with suitable properties for fine

ceramic processing is currently being purchased. Ceramic crucibles for relatively large amounts of glass melting have to be developed, which is planned for the next year, together with melting tests.

The discussion list in the Internet denominated *Vidros*, which was brought in the CeRTEV 1st year to a more modern and attractive virtual environment at https://groups.google.com and listavidros@googlegroups.com, will be focused aiming to increase the number of participants interested in glasses and glass-ceramics, in academy and industry. In the last years, we planned a campaign to invite active people in the glass field to join that list. This is going to be accomplished this year, together with the effort to divulgate CeRTEV to the national glass industry, taking the opportunity suggested in the I Workshop University-Industry on Glass Materials for creation of a National Industrial Advisory Board (NIAB) for the CeRTEV.

For the 3rd year, we planned to start writing and making accessible in Portuguese a book on Glass Technology, having the workers in industry and students in the field as the main target public. We identified several specialists on aspects of the glass production in Brazil, with solid experience in the glass industry, that are willing to collaborate in this challenge. For this, we also rely on the important partnership with a consultant, Dr. Mauro Akerman. The project of a Portuguese Book on Glass Technology was discussed last year and its format changed to make the glass content available faster and for a larger community than would a traditional printed book. An open collaboration platform was devised and named **Wikividros**. The website is in construction, hosted at https://wikividros.eesc.usp.br/, in collaboration with technical staff of STI-EESC at USP. An Open Source wiki software DokuWiki will be used to create a website that provides collaborative modification of its content and structure directly from the web browser. We requested the EESC board of directors for authorization for hosting **Wikividros** as a public website on the EESC server computer, for which the announcement due out soon. Then the formation of the content on glasses to compose the website will be promoted initially among the members of CeRTEV and its partners. We will return to this project in the next year.

The main result of the *I Workshop University-Industry on Glass Materials*, held at EESC/USP in September 11, 2015, was the suggestion of creation of a National Industrial Advisory Board (NIAB) for CeRTEV. About 30 names of potential advisers from the Brazilian industry on glass and related materials have been listed and will be invited for a meeting and launching of NIAB next year. Actions necessary to bring the CeRTEV team closer to the Brazilian industrial sector will be discussed in this event.

In a partnership with the Agencies for innovation of UFSCar and USP, we will organize a workshop to stress to the group members and collaborators how to detect interests and manage some of their research to innovation, to follow the patent literature, to get access to patents and market

reports, to estimate production costs and the potential market for a given technology, to avoid publications prior to patent request, and other important issues.

Efforts will be kept to implement lithium ion cells with glass and GC electrolytes in São Carlos, which can be tested in collaboration with the Münster Electrochemical Energy Technology center in Germany, a joint academic and industrial platform dedicated to the development of high-energy and high-power lithium ion batteries.

Finally, the properties and performance of catalysts will be tested in collaboration with colleagues at the Brazilian Laboratory of Bioethanol Science and Technology (CTBE) and the Brazilian Laboratory of Synchrotron Light (LNLS). Recently the contact with CTBE researchers has been reestablished and an expert in catalysis is being selected for a CeRTEV post-doctorate grant quota already approved by FAPESP to start in August 2016 to bridge the CeRTEV and the CTBE.

8. EDUCATION AND OUTREACH PROGRESS, 2015-2016

OVERVIEW

The CeRTEV Education and Outreach strategies and plan of action is divided in two main groups: *Group A* focuses on the development of professional qualifications in glass science and technology, while *Group B* has as its main objectives the diffusion of basic and glass science.

We will describe below the main actions taken in group A and B, during this third year of CeRTEV´s activities.

8.1 Group A: Development of professional qualification strategies in glass science and technology

As pointed out and justified in our previous reports, our main activity in this group is the development of a technical course "Glass Technology" to educate trained professionals for the glass industry, in order to address the lack of vocational training in this field. For this project, our partners are the ABIVIDRO, (Associação Técnica Brasileira das Indústrias Automáticas de Vidro - Brazilian Association of Automated Glass Industry) and the Paula Souza Center, an organization of the São Paulo State Government which now administers 214 Technical Schools (ETECS) and 59 Faculties of Technology (FATECS) in 163 municipalities of the state of São Paulo.

The "Glass Technology" course is planned to be a three semester course. The certificate will be delivered after three semesters of specialization. Students may start this specialization in parallel to the second year of high school or at any time if they have completed the high school. The name of the diploma "Glass technology" or "Introduction to Glass Technology" is still preliminary.

In our second report (2015), we described the activities on the "curriculum laboratory", which were fully completed. We also presented, in the 2015 report, the details – name and number of hours - of each discipline to be offered during the course.

During the last year, the location of the first course was practically decided. The city of Mogi das Cruzes, which is 70 km distant from the city of São Paulo, meets two important requirements: it is the site of an important Brazilian glass industry, named Nadir Figueiredo, which produces glasses and tableware, and also holds one of the Technical Schools from Paula Souza Center. These Technical School has already some laboratory infrastructure that will be used and modified to accommodate the new "Glass Technology" course. However, to adapt the existing laboratories for the needs of the new course, the Paula Souza Center must plan and draw a new lay-out of these

laboratories, and also estimate the necessary expenses. Therefore, a Memorandum of Agreement will be signed between Paula Souza Center and Nadir Figueiredo, through ABIVIDRO.

The current (June 2016) status of this project is following: Paula Souza Center has prepared and sent to ABIVIDRO, who forwarded on June 8th, 2016 to Nadir Figueiredo, the following documents, listed below:

- Proposal of Cooperation and Agreement between Nadir Figueiredo Company and the Paula Souza Center.
- Report of the visit, which took place with the participation of CeRTEV´s Coordinator on Education and Outreach, to the existing Technical School in Mogi das Cruzes,
- Survey report of the existing infrastructure in the Unit of Paula Souza Center in Mogi das Cruzes.
- Layout of the new laboratories proposed for the new "Glass Technology Course".

These agreements and other documents mentioned above aim at securing financial help from Nadir Figueiredo (through ABIVIDRO) to build or adapt the laboratories planned for the "Glass Technology" in order to speed up the offering of the first class of the course. Following Centro Paula Souza rules, they cannot authorize the implantation of courses whose infrastructure is not completed. We, at CeRTEV, are closely following all steps of the agreement between Nadir Figueiredo/ABIVIDRO and Paula Souza Center, in order to support the beginning of the course for the first semester 2017. After the analysis, by Nadir Figueiredo, of the documents sent by ABIVIDRO on June 8th, 2016, we will have a new position.

Another educational activity for undergraduate and graduate students is the creation of a channel on YouTube

(https://www.youtube.com/playlist?list=PLYkqBrOsu1yCxMLTcb7Y6zwj_smIb5w5x) to make available the classes on Structure and Properties of Glasses, taught by Prof. Edgar Zanotto, to the undergraduate students of the Materials Engineering Course from UFSCar. Topics about history, structure, crystallization, glass ceramics, glass properties and applications are discussed during about 1 hour classes.

8.2 Group B: Diffusion of basic and glass science

ACIEPE

In continuation of what was described in our first report, CeRTEV offered during the past two semesters an UFSCar/ACIEPE (Atividades Curriculares de Integração de Ensino, Pesquisa e Extensão, - activities for the integration of education, research and extension) event spearheaded by the UFSCar´s Rectorate. As pointed out in our previous reports, in this activity, undergraduate students from UFSCar, under the supervision of a CeRTEV member and UFSCar faculty, have access to a public elementary school, in which they present and discuss some topic in basic science. In a second step, those elementary school students, aged 9-12 years, visit the Laboratório de Materiais Vítreos, LaMaV/DEMa/UFSCar, one of the main CeRTEV´s laboratories.

During the second semester 2015 and first semester 2016, CeRTEV offered three ACIEPEs

- "Engineers and Scientists of the Future", already described in the 2015 report, in which 100 students from elementary schools of the city of São Carlos participated.
- "Chemistry in the kitchen" (50 students, 60 hours). This ACIEPE joins professionals of different areas such as winemakers, chef of haute cuisine, beer sommeliers, espresso coffee makers, scientists, among others, to talks and tasting activities during 1 semester. The students are from different courses of UFSCar and 10 places are reserved to people from the São Carlos community, encouraging the application of the language for science diffusion, aiming to teach topics of science such as fermentation, acid-base properties, glassy tableware for cooking and for measuring ingredients and "molecular culinary" techniques.
- The "Science Gourmet" (40 students, 60 hours) activity promotes, through films exhibitions, the discussion of science in general, aspects of gastronomy, biographies of chefs and aspects of film production. Similarly to "Chemistry in the Kitchen", undergraduates and people of the city of São Carlos participate in the weekly activities during the first half of the year.

EVENTS

67th SBPC - Acronym for Sociedade Brasileira para o Progresso da Ciência or Annual Meeting of the Society for the Advancement of Science, held in São Carlos, July 12-18, 2015. *(co-organization)*

Co-Organization of Young SBPC:

The annual meeting of SBPC gathered in São Carlos approximately 20,000 people, including exhibitors, visitors and participants. The Young SBPC aims to provide a dynamic contact between children and adolescents and science, scientific practice and scientists through several activities such

as workshops, lectures and exhibitions. The program of Young SBPC 2015 had two main activities: the show *Photographia* at School and the Young Tent (in Portuguese: *Tenda Jovem*). In total, 79 schools participated in the show *Photographia* at School, with a total of about 600 photographs. The Young Tent assembled 27 exhibitors, and offered 9 short courses and 2 workshops in the areas of biology, physics, chemistry, literature, geology, etc. It was also part of the young program of the SBPC two theatre performances. The Young Tent received about 5,000 students from schools from São Carlos and region to perform previously scheduled guided tours.

Together with the Ouroboros Group for Dissemination of Science, the CeRTEV organized the activities of the Glass World stand with experiments and demonstrations involving glass and glass devices, such as: "Optical Fiber", "Tempered Glass", "Science and Inclusive Art" exhibition with photographs of "Crystals in Glass" and 3D molds of those crystals. In addition, two stands in the SBPC Innovation Space showed the basic and cutting-edge research in the field of glass, done by CeRTEV.

National Week of Science and Technology - September, 20-23, 2015. (Semana Nacional da Ciência e Tecnologia – SNCT) *(participation)*

The activities of the National Week of Science and Technology were held at UFSCar from 20-23 October, 2015. The Science Circus Tent received 1,000 students from schools in the region with activities such as the exhibition Science and Inclusive Arts, the video display on glasses, and 12 photos of glass crystals with 3D molds in order to allow the visually impaired to touch them.

Adriana Yumi Iwata, designer and Master of Chemistry from the Ouroboros Group, coordinated a "Mangá" (Japanese Comics and design) workshop for the participating children of SNCT. During this workshop, "Mangá" comics volume 1 which is related to the history and production of glass were distributed to the children.

XII CIRCUS OF SCIENCE, September 22-23 2015 *(participation)*

The "Circus of Science", a traditional scientific outreach event of UFSCar was held, in 2015, during the National Week of Science and Technology. This event gathered groups of Fellows of the Tutorial Education Program (PET) of Chemistry, Physics, Mathematics and Biology, the Ouroboros Group for Dissemination of Science, and also students from elementary schools of the city of São Carlos and the São Carlos region. These last groups brought demonstration experiments to this science fair. PET groups presented experiments and interacted with the 5,000 visiting students in

these two days of the event. The Ouroboros group contributed with two theater performances (E = mc^2 and "Lucis est vita"), chemistry shows and theater workshops. During the shows, the art and science of glassy materials were presented among other experiments whetting curiosity and arousing interest to the scientific world.

XIII CIRCUS OF SCIENCE, May 9-11, 2016 *(organization)*

The XIII Circus of Science from UFSCar was organized in May 2016 by CeRTEV, in partnership with the Functional Materials Center (CDMF) (another CEPID from Fapesp) and the Pró-Reitoria de Extensão PROEX-UFSCar. Differently from former editions, in which the Circus was held under a circus tent, the XIII Circus of Science took place in several areas in UFSCar such as the buildings of the Teacher Training Center, research building "Petrobras", the Observatory and also at the Vitreous Materials Laboratory, LaMaV. A total of 15 hours of activities were conducted for 30 secondary schools (6 of them private and 24 public). Those activities reached 2,100 visitors. The organizing team included 34 guiding monitors, 100 specific (for each activity) monitors and 5 teachers. Activities carried out included: Glass Museum, workshop and reading of Comics ("Mangás"), particularly the Histories of Glass in Comics 1 and 2, workshop on Molecular Gastronomy and activities of Tutorial Educational Program (PET) of physics, chemistry, mathematics and biology. The Open Laboratory of Interactivity contributed by giving lectures and showing videos of their collection, about UFSCar *versus* Aedes project. (UFSCar *versus* Aedes is a project which aims to raise awareness on the importance of preventing the spread of the Dengue virus transmitted by Aedes Aegypti.)

The Ouroboros Group presented the play "Go away Zika!" (Sai Zika – Zika is another disease transmitted by the mosquito which, together with Chikungunya is causing troubles and concerns in Brazil and in the world) and also performed its show of chemical experiments. The public state schools brought 12 experiments for the Science Fair and CerSusChem Group also participated by conducting Green Chemistry experiments.

In the Observatory building several exhibitions took place: geosciences, photos from star birth and meteorites, as well as a daytime observation of the sun and the passage of Mercury in front of this star

SUMMER MATERIALS ENGINEERING SCHOOL FOR HIGH SCHOOL STUDENTS AND TEACHERS - EFEM (Dissemination of "What is Materials Science and Engineering?" to high school students - July, 2015)

The Summer Materials Engineering School, EFEM, consists of 3 days of activities and seminars for high school students coming from public and private schools. This dissemination project has the intention to spread the Materials Engineering course for high school students and teachers, showing the potential of material engineers´ role in science and technology. It is also shown that this area of knowledge is a strategic sector for economic development. One of the objectives is to promote a greater interaction with the local and regional community, thus fulfilling a social function of democratization of knowledge and making the school a showcase for the Undergraduate Program at UFSCar's Materials Engineering course. The EFEM program, for 40 selected high school students coming mainly from public schools, was dedicated to show basic concepts of Metals, Ceramics (traditional, glass and glass-ceramics) and Polymers.

9. WORKSHOPS / LECTURES / COURSES

São Paulo Advanced School on Glasses and Glass-ceramics

The ***São Paulo Advanced School on Glasses and Glass-ceramics***, organized by CeR**T**EV, was held during August 1-9, 2015, in São Carlos, SP, Brazil. It counted on generous financial support from the São Paulo Research Foundation (FAPESP), the Department of Materials Engineering (DEMa-UFSCar), the Institute of Physics (IFSC)-USP, Brazil, and Owens-Illinois, USA.

The School was widely advertised during 2 months at CeR**T**EV´s email list of glass researchers, at Klaus Bange´s 2000 emails list of "glass" researchers and engineers, and on key web sites related to glass research, e.g.: American Ceramic Society, Society of Glass Technology, International Commission on Glass, Linkedin (glass research and glass technology groups), Brazilian Ceramic Society, Brazilian Physical Society, FAPESP, SBPMat (Brazil-MRS), as well as in some journals: Nature, ACerS Ceramic Bulletin, and Glass International.

The participants were selected among hundreds of applicants from around the globe. The selection criteria included a thorough analysis of their CVs, 2 recommendation letters, and the scientific standing of their current research group. The large number of applications and the outstanding quality of many of them made this process quite difficult. In the end, approximately 100 highly qualified students from 19 countries were accepted. Among the international participants were 12 from the US, 8 from France, 7 from Germany, 6 from India, 3 from Italy, 3 from Colombia, 3 from Russia, 3 from China, 2 from Canada, 2 from Argentina, 2 from Turkey, 2 from the Czech Republic, and one each from Spain, Finland, Korea, Japan, UK, Portugal and Tunisia, plus about 40 students from Brazil. Twenty extra guest students and professors were allowed to attend the classes.

The organizers covered the travel, meals and accommodation expenses of most of the selected PhD students and instructors. Fifteen international students covered their own travel expenses and we covered the local costs.

The school program covered several key, state-of-the-art, topics on glass and glass-ceramics, ranging from structural characterization to relaxation, thermodynamics, crystallization, and properties. The program comprised 11 lectures of 2 hours each, and 3tutorials about the powerful SciGlass database/software –with a free user license for all the attendees during the School days. The program and other details can be seen at http://www.certev.ufscar.br/g-cc-brasil.

The vast majority of received feedback (see Appendix) indicates that the school was a great success and should be repeated. This was likely one of the largest short courses focusing on glass education worldwide. We are confident that the attendees have benefitted greatly from the information and perspectives presented at this school and that they returned home to their on-going research projects with inspiration and new ideas. It is also a pleasure to see that students formed a network among them and that they are in contact, for instance through Facebook. Also, it is with great pleasure that we met and recognize some of these students in the main congresses of the area, and to see that, in those congresses they are sitting and discussing together. In this way, Fapesp´s main goals from this school were fully reached. Indeed, we hope to remain in touch with these future leaders in academic and industrial glass research, to develop collaborations and joint research projects with them and their advisors in the future. Some of those collaborations have already started.

Undergraduate and post- graduate courses on glasses

Distinguished Professor Prabhat K. Gupta, retired from the Ohio State University, USA, delivered a high level 20 hour course on ***Relaxation and Glass Transition*** to 12 post-graduate students and professors of the Federal University of São Carlos. The lectures were video taped and are available at the CeRTEV website (in English).

CeRTEV's director, Professor Edgar Dutra Zanotto, delivered 2 short courses of about 8 hours on the ***Fundamentals and Applications of Nucleation and Crystallization in Glasses*** in the following events: University of Chile, Santiago, Chile, January 2016; International Congress on Glass, Shanghai, China, April 2016; ***Glass and Optical Materials Meeting***, ACeRS, Madison, USA, May 2016.

Prof. Zanotto also delivered a 60 hours undergraduate level course on the ***Structure and Properties of Glasses*** at UFSCar (August- December 2015); and a 30 hour post-graduate course on ***The Vitreous State*** (March- June 2016) at UFSCar. The lectures of both courses were video taped and are available at the CeRTEV website (in Portuguese).

Prof. Oscar Peitl delivered a 60 hours undergraduate level course on the ***Glass Technology*** at UFSCar (August- December 2015).

9.1 LECTURES FROM THE OUROBOROS GROUP FOR DISSEMINATION OF SCIENCE

The Ouroboros Group for Dissemination of Science presented lectures at different Educational Center, including:

Federal University of Uberlandia (UFU) - Ituiutaba (30 students) "Science Dissemination: the experiences of Ouroboros Center"

Federal University of Goiânia UFG- Catalão (50 students) "Ouroboros group for Dissemination of Science: science, art and inclusion

Federal University of São Carlos - UFSCar (30 students) "Ouroboros: 10 years publicizing science"

The invited lectures allow the Nucleus Ouroboros to share experiences related to the interface science-art-inclusion and to motivate people of different places to try these teaching-learning practices involving the respective specific knowledge.

Molecular Gastronomy Course

Molecular Gastronomy Course was offered at:

Federal University of Paraná, UFPR - Curitiba-PR to 40 chemistry students.

Federal University of São Carlos, UFSCar- São Carlos-SP, to 10 biology students.

Federal University of Goiânia, UFG- Goiania-GO, to 20 chemistry and biology students);

Federal University of Uberlandia, UFU- Ituitaba-MG, to 30 history, chemistry and biology students, and also to teachers from the "food technical course" (*curso técnico em alimentação*).

Technical State School (*Escola Técnica Estadual* – ETEC) Itapira-SP, to 80 high school students.

The modules "flavoring" and "tasting" (4 hours each) and molecular gastronomy (4 hours) from the main course offered by Ouroboros were presented to students in all Brazil in specific events, mainly for sharing ideas but also to promote and stimulate e studies in co-related areas.

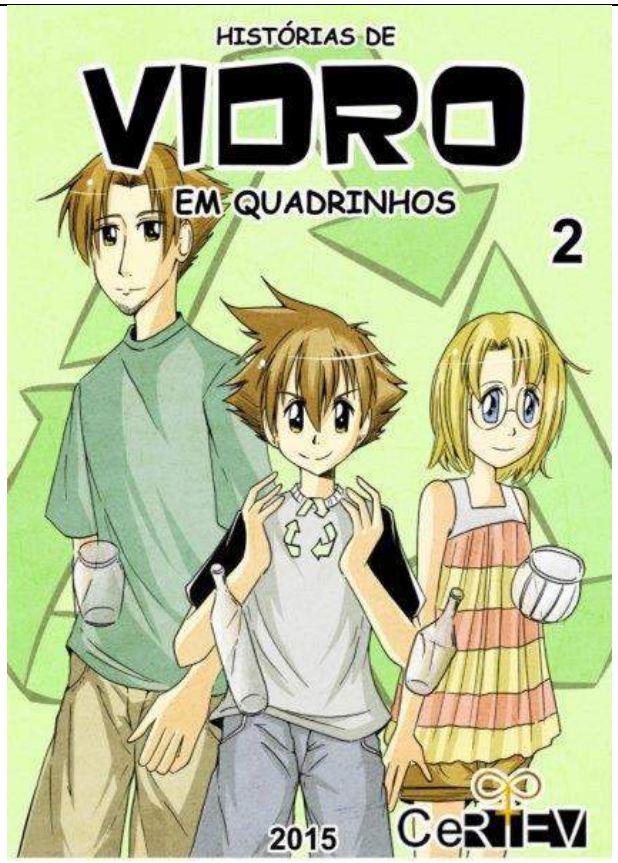
9.2 PROGRAME "Science at 7 pm" (Ciência às 19hs)

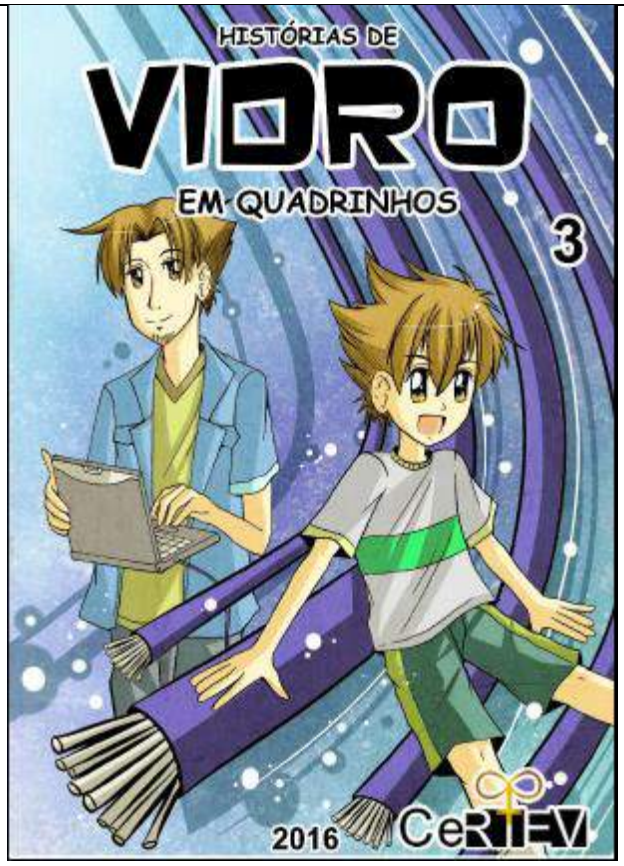
This Project is Coordinated by: Prof. Luiz Agostinho Ferreira, Diretor of Physics Institut of São Carlos – University of São Paulo IFSC/USP, with the participation of three Fapep´ CEPIDS. CEPOF, CDMF and CeRTEV.

9.3 PRINTED MATERIALS

9.3.1 GLASS STORIES Comics 2 and 3

The comics (Mangá Style), Glass Stories Volumes 1 is about general properties of glass. 2.000 copies of this first volume were distributed in the SBPC, SNCT and XIII Circus of Science events. During 2015-2016, a second and third volume about glass recycling and glass fiber, respectively, were written. These new two volumes are already ready.



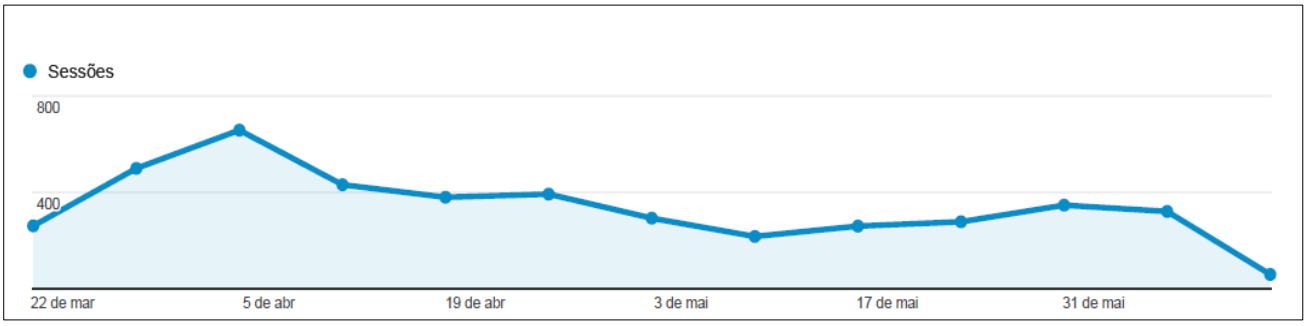


9.3.2 SOW SCIENCE Project – Posters in the São Paulo Subway (This project is realized in partnership with FAPESP´s CEPID on Genome)

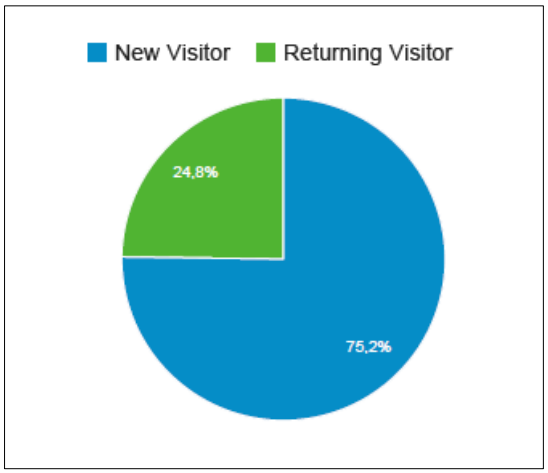
In partnership with the CEPID Genome (University of São Paulo- USP), CeRTEV promoted scientific dissemination in the green and blue lines in the subway of São Paulo through three illustrative posters on glass characteristics. The Genome CEPID had an agreement with the company of the São Paulo subway (Companhia do Metropolitano de São Paulo), so that posters for the dissemination of Science could be shown in the subway wagons, free of charge. In 2016, Genoma CEPID kindly asked to the São Paulo subway that this project could be extended to other CEPIDs.

We know that, up to now, three CEPID have taken part in this project: Genome, "Metropolis studies" and our CeRTEV.

In this way, 300 posters (above) were shown in the Green and Blue lines of the São Paulo subway. It is worth to say that the Green Line from São Paulo Subway has an average of 600,000 of passengers a day (from: http://www.metro.sp.gov.br/metro/numeros-pesquisa/indicadores.aspx). To support this project, a virtual page (www.vidro.ufscar.br) was created so that the public can access more information about glass in an accessible language. The poster exhibition started at March, 20th, 2016. Data provided by Google analytics show that during the period March 20th – June 14th, UFSCar page (www.vidro.ufscar.br) had more than 5,000 accesses, 74% from São Paulo state.



Accesses per week at the web page www.vidro.ufscar.br – From March 20th to June 14th, 2016.



Percentage of new and returning Visitor in the period March 20th to June 14th

Besides the accesses to our website, the posters in the São Paulo subway brought new visitors to LaMaV. One of them, from glass industry, more specifically, from the glass transformations industry, Primo Vidros (http://www.primovidros.net.br/) . He was really amazed about our laboratory, and told us that there are so few available information about glasses. We had several e-mail searching and questioning about the availability of courses in Glass. These particular questions lead us to reaffirm the importance of the technical course in glasses that CeRTEV is organizing (paragraph 2, Group A)

9.3.3 RADIO PROGRAM: VITREOUS MINUTE (Radio UFSCar, in São Carlos)

The program on Radio UFSCar (95.3 FM) presents curiosities and scientific information related to the material "glass". In narratives of about 1 minute, with background sounds from objects made of glass such as flutes and goblets, listeners can learn more about this interesting material. The subjects addressed included: the glassy state, glass-ceramics, tempered glass, bioactive glasses, optical glasses, among others.

9.3.4 THEATER PERFORMANCES:

9.4.1 INDIVIDUAL THEATER PRESENTATIONS:

33 Science Theater presentations were done in 2015-2016

By Ouroboros and Group "Olhares" – (a group formed by visually impaired or blind people)

Title of the presentations:

Lucis est Vita

Petit Curie

Magic X Science

The Gaia Treasure

Peter Q Pan: searching for Ouroboros (premier 25-26 June)

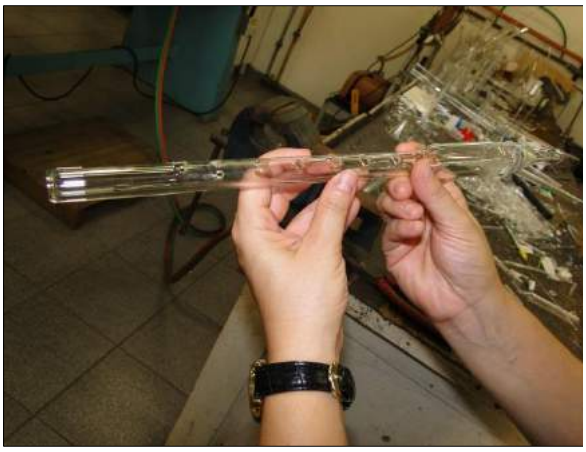
9.4.2 SCIENCE THEATER WORKSHOPS

Molecular Pan and June's Chemistry was created and presented by the 20 people who participated of this activity of 60 hours during 2015.

9.4.3 THEATER SOUND EXPERIMENTATION (pan flute, flute, chimes and bowls)

Glass instruments and sound experimentation are being confectioned through the first semester of 2016. The musicians from the Ouroboros Group and the glassmaker's master from the Chemistry Department – UFSCar are working on this project to create a mini orchestra with instruments made of glass. These projected wind and percussion instruments allow the experience of different sounds in the notes of glassy objects.

Sound of Glasses



Vitreous flute

Pan Flute made of glass

Pan Flute made of glass illuminated with led

10. FURTHER ACTIVITIES

Aiming to improve the interaction with the general public, a visit to Cadoro Murano Glass factory in Poços de Caldas-MG was organized in February 2016, with the participation of Prof. Karina Lupetti, Prof. Ana C.M. Rodrigues, (CerTEV´s Education and Outreach coordinator) and two post-doc from LaMaV, Shiv Prakash Singh and Swarup Kundu. Processes for making artistic glasses were demonstrated. This visit was organized to enlist Cadoro factory's assistance in some of CeRTEV's future scientific divulgation activities.

Final remarks:

During the period of this third report (2015- 2016)**,** CeRTEV greatly increased and diversified the number of activities dedicated to the Dissemination of Science. The partnership with the Ouroboros Group proved to be very rich and very fruitful. The Sow Science project or "Subway project" brought more than 5,000 accesses to our web site. Besides these accesses, CeRTEV received several e-mails with questions about glass and looking for glass courses. The latter reaffirm the importance of our "Technological Course" on glass. Concerning this Technological Course, an agreement between ABIVIDRO and Paula Souza Center has been sent to Nadir Figueiredo on June, 8th, 2016. This agreement aims to provide financial support to equip the laboratories for this course. We are following closely all related steps to support this agreement. Resulting from all above described, CeRTEV is now very proud to contribute to the Dissemination of Basic and Glass Science in São Paulo State and hopefully in all Brazil.

Appendix I – Photos from diferent activities:

Glass sound experience in Circus of Science

Go away Zika! presentation in Circus of Science

Molecular Gastronomy course in II Jalequim-GO

The Gaia's treasure presentation in II Jalequim

Lucis est Vita presentation in UFSCar library

Show of Science in National Week of Sci. And Tech

Show of Science in Circus of Science

Molecular Gastronomy course for High School students

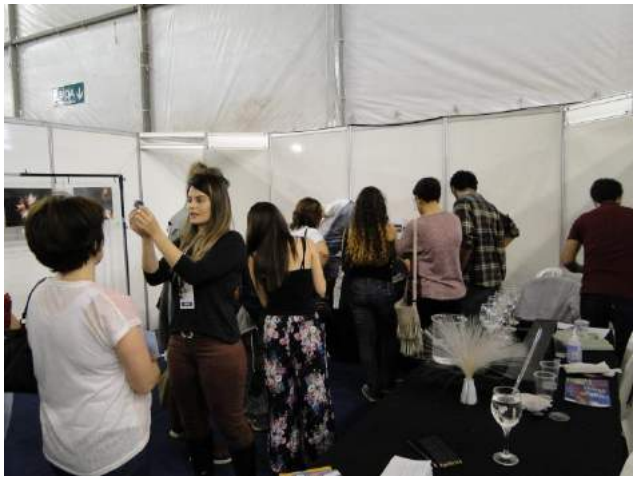
Technical Visit to Cadoro factory – handcraft production of vitreous objects

Lucis est vita presentation in Science on Stage 2015

Glass properties in Circus of Science 2015

Molecular Gastronomy course in UFPR-Curitiba

Participants in G & GC Advanced School



World of Glass activities in SBPC-2015

SBPC-2015 visitors

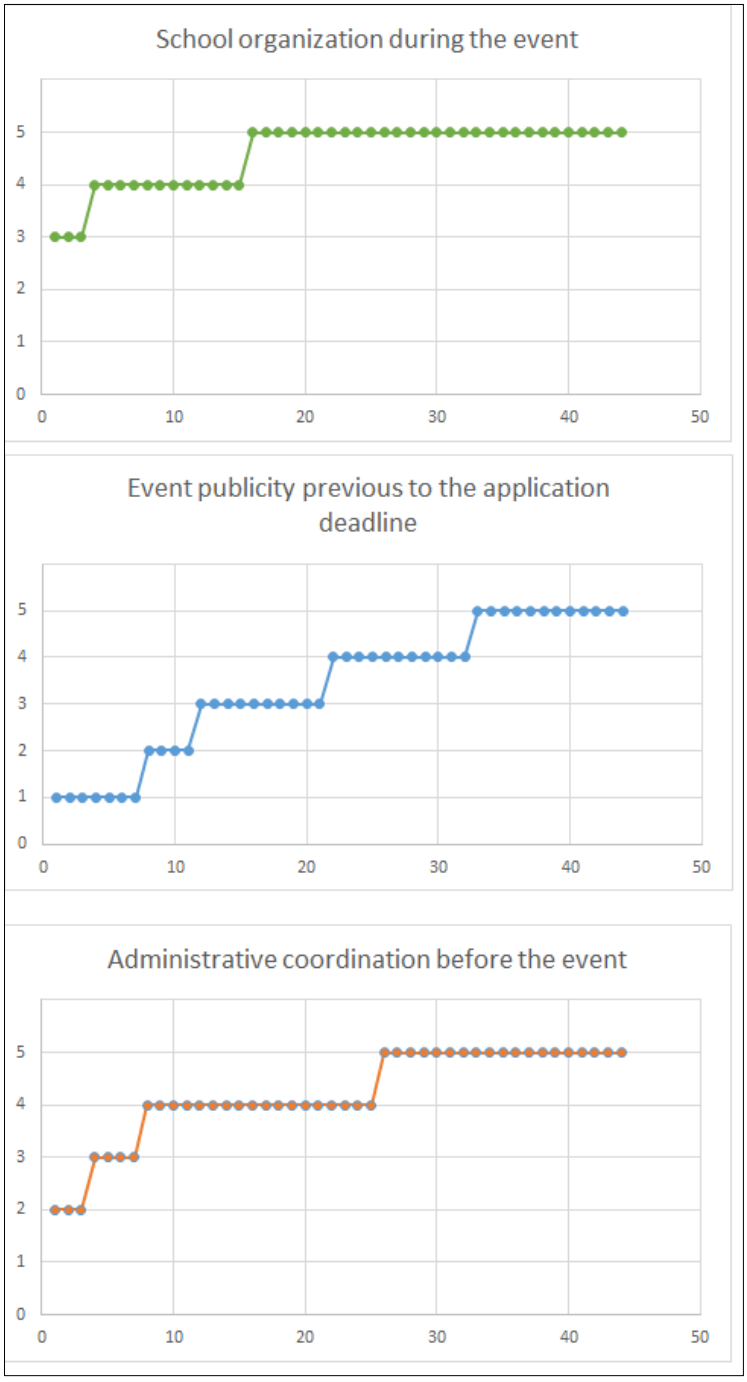
Vitreous sound experiences in SBPC- 2015

Appendix II:

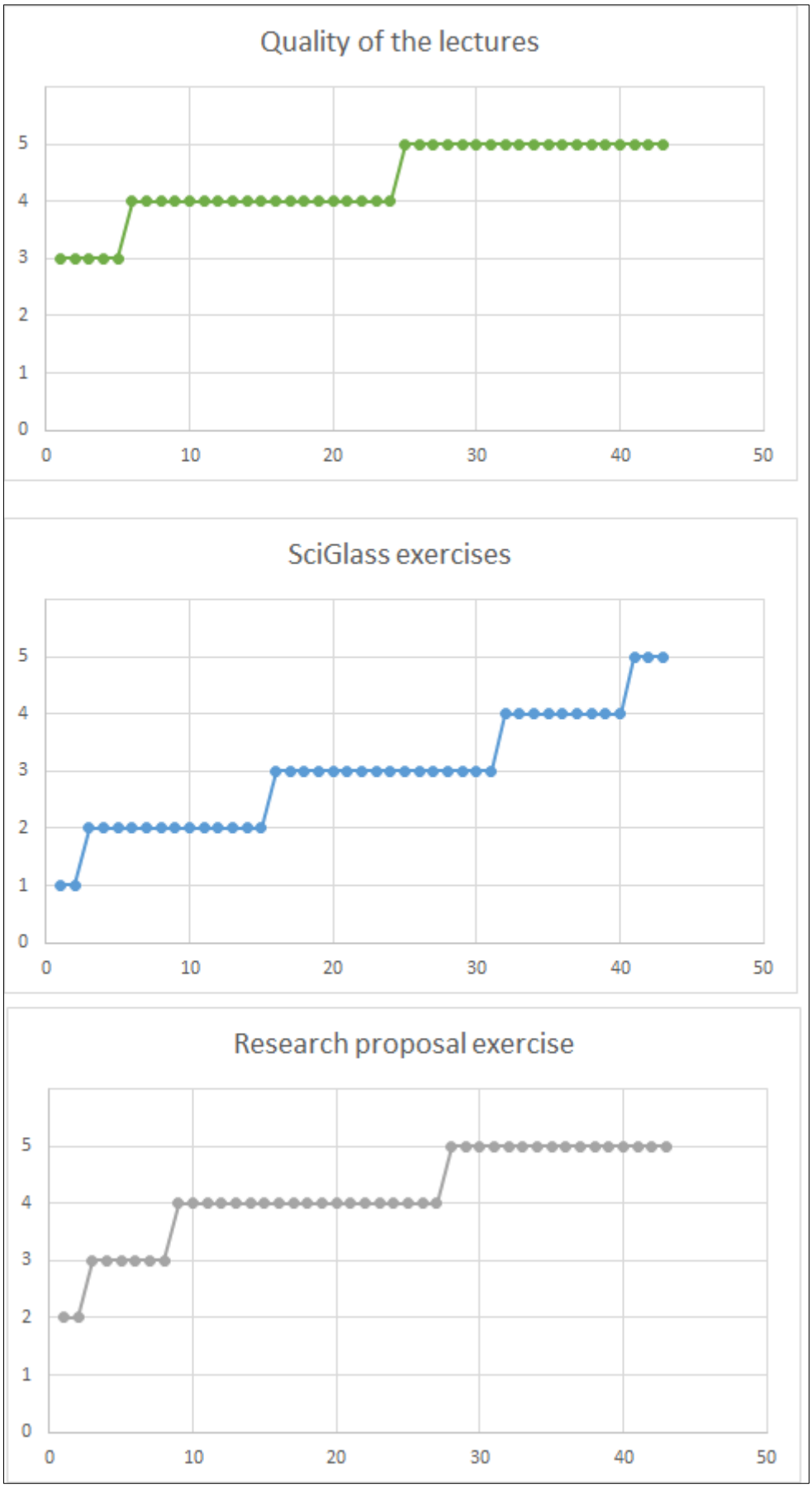
Evaluation of the São Paulo Advanced School on Glasses and Glass-ceramics, by the participating students.

The plots shown below are self-explanatory and clearly demonstrate that the overall evaluation of the School by the students is highly satisfactory (5=excellent; 0-1=poor). And this was, in the end, the School´s main objective, therefore, we consider it a huge success!

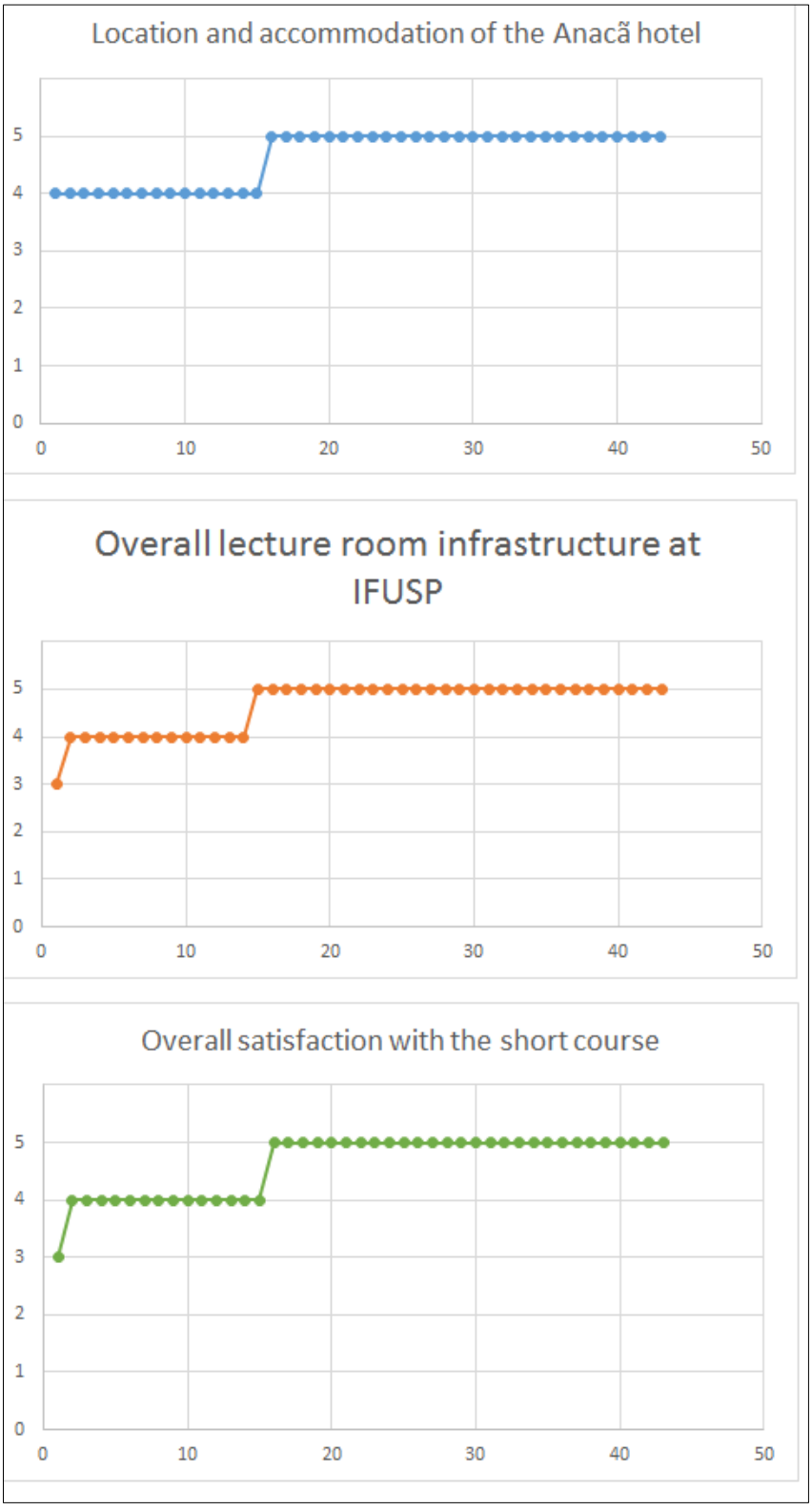
ORGANIZATION

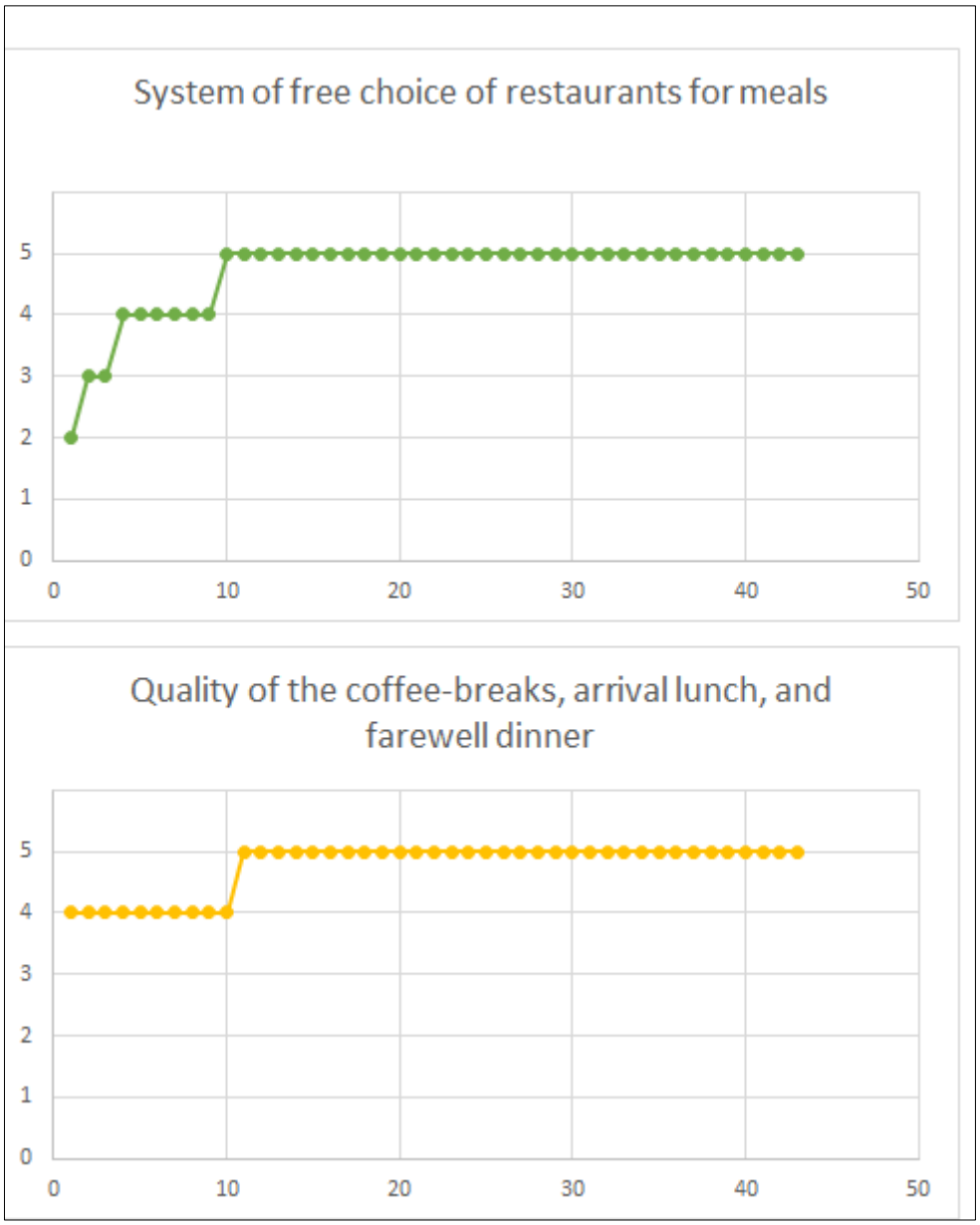


CLASS SUBJECTS

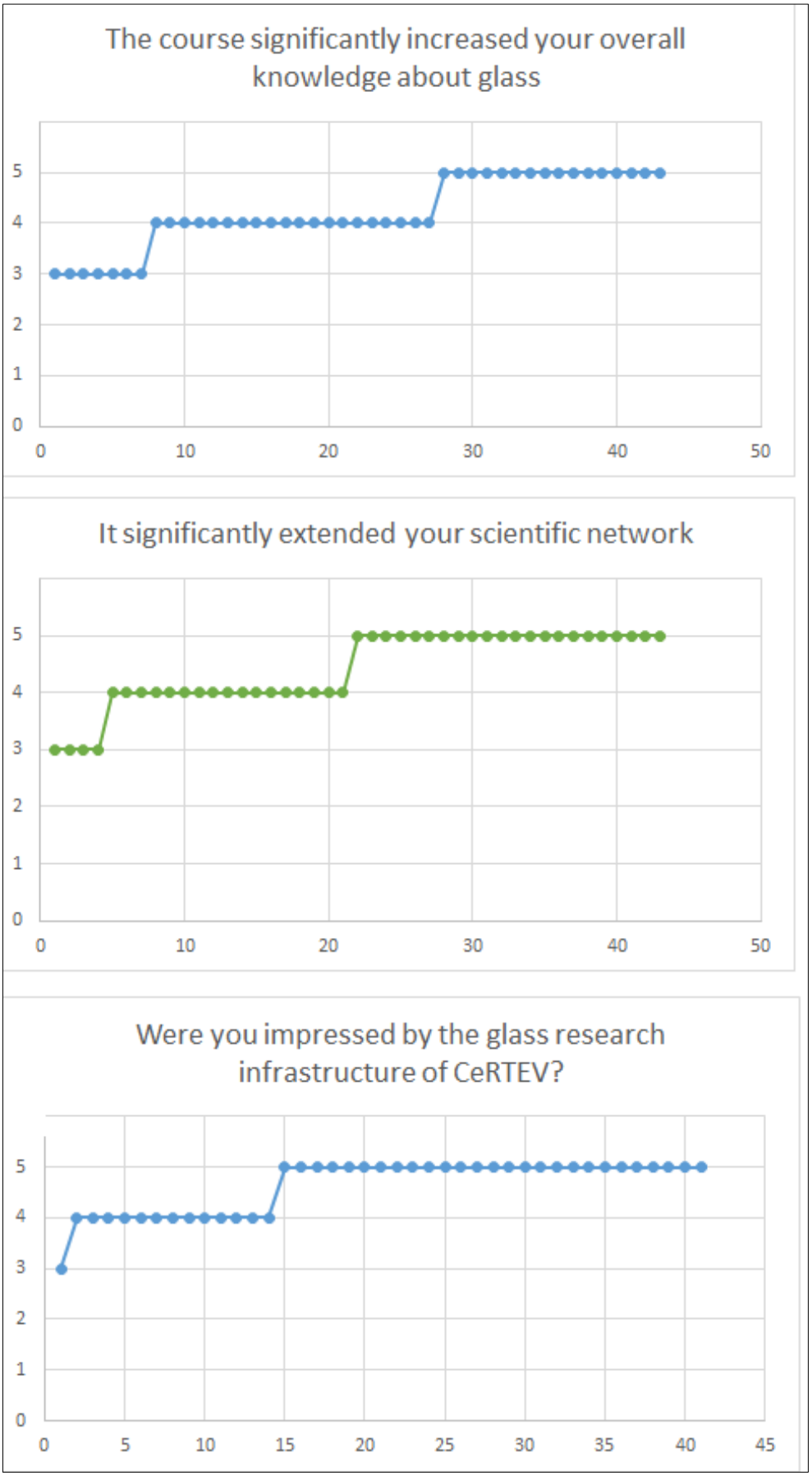

Quality of the lectures
5
4
3
2
1
0
0
10
20
30
40
50
SciGlass exercises
5
4
3
2
1
0
0
10
20
30
40
50
Research proposal exercise
5
4
3
2
1
0
0
10
20
30
40
50

GENERAL EVALUATION

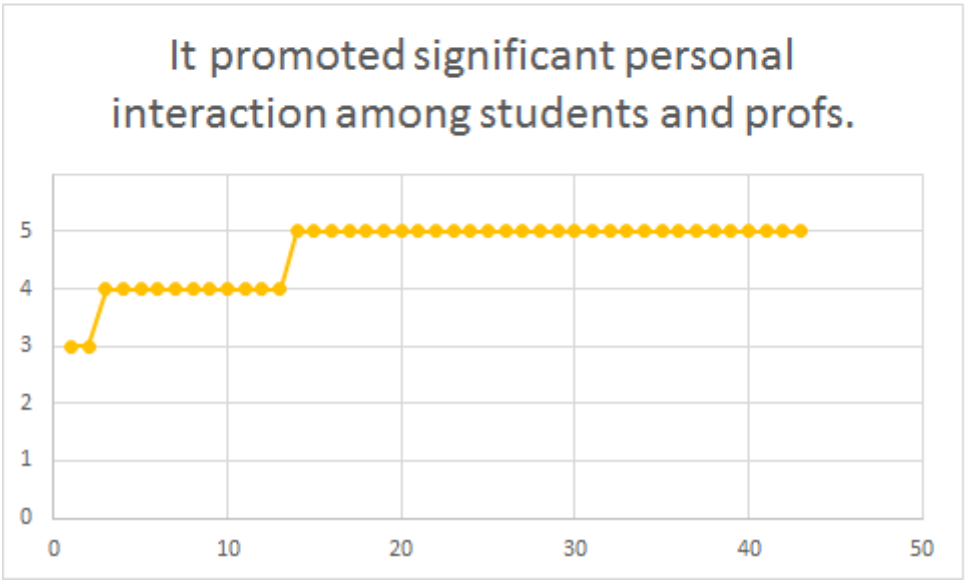


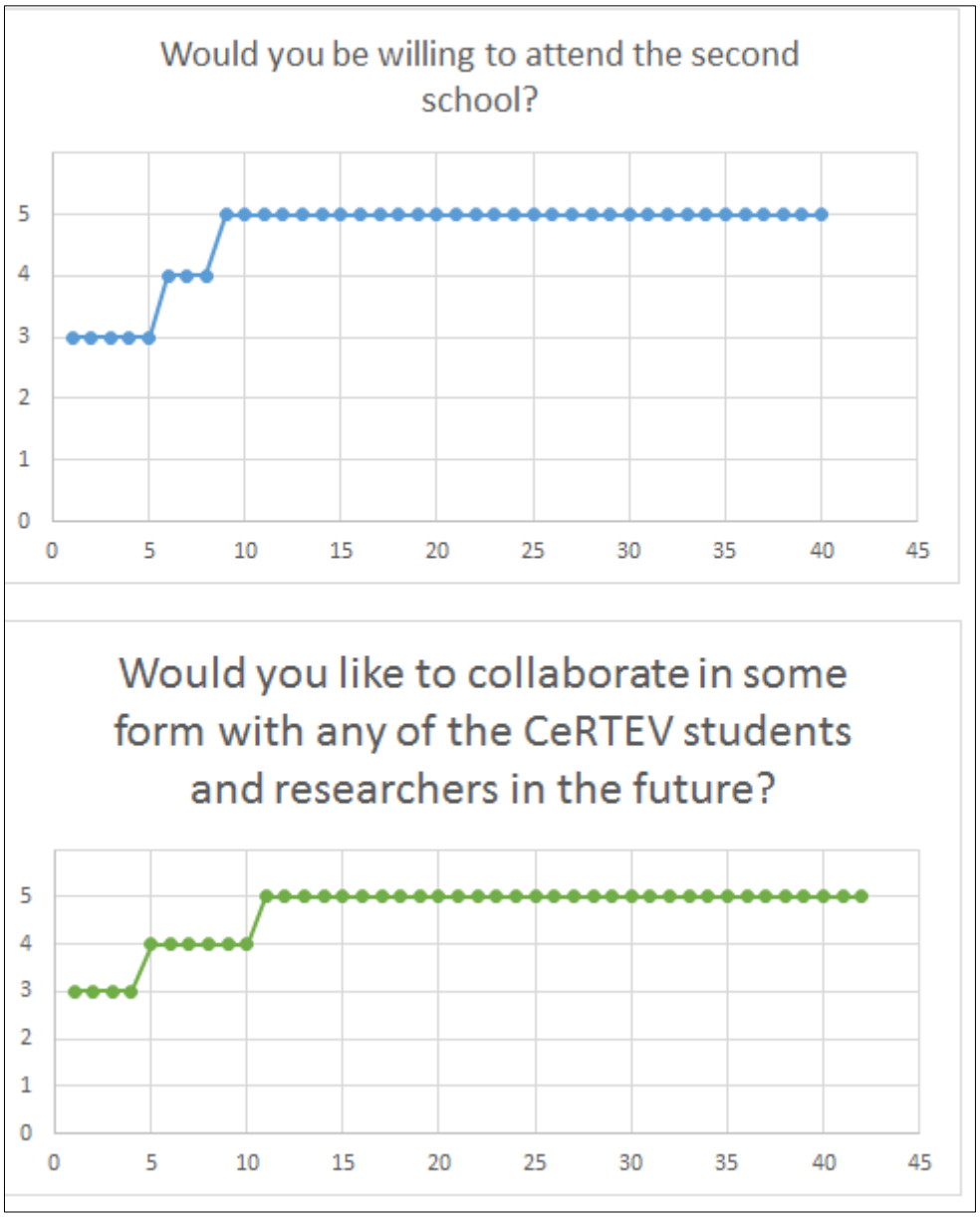

System of free choice of restaurants for meals
0
1
2
3
4
5
0
10
20
30
40
50
Quality of the coffee-breaks, arrival lunch, and farewell dinner
0
1
2
3
4
5
0
10
20
30
40
50

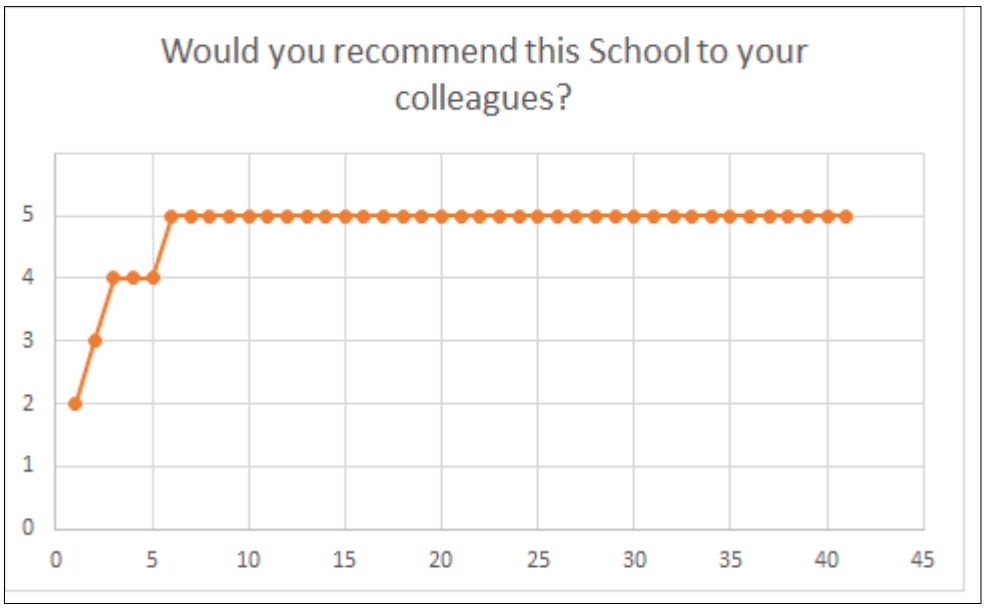
OTHERS


The course significantly increased your overall knowledge about glass
0
1
2
3
4
5
0
10
20
30
40
50
It significantly extended your scientific network
0
1
2
3
4
5
0
10
20
30
40
50
Were you impressed by the glass research infrastructure of CeRTEV?
0
1
2
3
4
5
0
5
10
15
20
25
30
35
40
45


It increased your knowledge about what is going on in Brazilian glass research
5
4
3
2
1
0
0
10
20
30
40
50


It promoted significant personal interaction among students and profs.
5
4
3
2
1
0
0
10
20
30
40
50


Would you be willing to attend the second school?
5
4
3
2
1
0
0
5
10
15
20
25
30
35
40
45
Would you like to collaborate in some form with any of the CeRTEV students and researchers in the future?
5
4
3
2
1
0
0
5
10
15
20
25
30
35
40
45


Would you recommend this School to your colleagues?
5
4
3
2
1
0
0
5
10
15
20
25
30
35
40
45

11. Descrição sucinta e justificada da aplicação dos recursos de Reserva Técnica e Benefícios Complementares no período coberto pelo Relatório

Apresentação de seção específica para aplicação dos recursos de Benefícios Complementares
Processo 2013/07793-6 - Prestação de Contas Parcial

SERVIÇO DE TRANSPORTE

DESCRIÇÃO	VALOR	DATA DE EMISSÃO	JUSTIFICATIVA
Passagem aérea - RP/RJ/RP (setembro/2015)	R$ 365,80	23/7/15	Passagem aerea para participar do congresso da SBPMat já devidamente justificado com cartas convites, certificado de participacao, apresentacao trabalho, etc.
Passagens aéreas EUA	R$ 3.044,52	1/6/15	Transporte aéreo para Prof. Edgar para participação do 14th International Conference on The Physics of Non-Crystalline Solids, no período de 19 a 27/09/2015 onde apresentou o trabalho intitulado “Crystal nucleation in glass-forming liquids revisited” em Niagara Falls, NY, USA.
Passagem aérea - SP/Dubai/Bangkok/Dubai/SP	R$ 4.209,84	3/7/15	Passagens ida e volta SP-Bangkok, para participação no Annual Meeting, International Commision on Glass, 20-23 setembro 2015, com apresentação de trabalho oral.
Passagens aéreas - França	R$ 2.707,97	20/8/15	Tendo em vista que a conferência foi na Europa (França) necessitei de uma passagem aérea para participar desta conferência onde apresentei trabalho
Passagem aérea - RP/RJ/RP	R$ 620,00	27/10/15	Passagem Decolar Congresso Rio de Janeiro 27/09 a 01/10 XIV Brazil MRS Meeting
Passagens de ônibus	R$ 203,62	27/10/15	Participação convidada na Mesa Redonda "Prospects for International Scientific and Technical Cooperation -21st Century Challenge" e apresentação oral convidada "Bio glass and glass-ceramics for medical applications" no Interdisciplinary Youth Scientific Forum «New materials. Science days. Saint-Petersburg 2015», de 20 a 22/10/2015, além da apresentação oral convidada "Innovation at University of Sao Paulo and the Center for Research, Technology and Education in Vitreous Materials, Brazil" em sessão plenária do Forum "Innovation and technological cooperation in the field of chemistry for the development of the North-West region of Russia", 22 a 23/10/2015, no Institute of Silicate Chemistry da Russian Academy of Science, em St. Petersburg, Russia.
Passagens aéreas/Xangai	R$ 2.703,06	16/3/16	Passagem aérea para Xangai, onde participou do Congresso Internacional de vidro e apresentou uma palestra como convidado
Passagens Aéreas/Russia	R$ 3.544,58	16/3/16	Participação no 20th Research Workshop Nucleation Theory and Applications, de 14/04/2016 à 25/04/2016, em DUBNA, RÚSSIA, com apresentação oral do trabalho "The Effect of Particle Morphology on the Sintering of a Diopside Glass"
Passagens aéreas/Madison-EUA	R$ 3.340,56	26/4/16	Passagem aérea para a Madison, Wisconsin, EUA, onde apresentei uma palestra como convidado na reunião da American Ceramic Society e recebi um prêmio desta sociedade
Passagens Aéreas Shangai - ICG 2016	R$ 5.111,79	26/4/16	Transporte aéreo para Prof. Edgar para participação do “24th International Congress on Glass” no período de 03 a 12/04/16 para apresentação de trabalho intitulado “Creation of a Glass Technician Training Course in Brazil” em Shanghai, China
Passagens aéreas/Varna-Bulgaria	R$ 4.274,54	27/4/16	Passagem aérea para Varna, onde participou na Conferência Zing de sólidos Aplicações de RMN de Estado para Ciência dos Materiais e apresentou uma palestra como convidado

SERVIÇO DE TERCEIROS

DESCRIÇÃO	VALOR	DATA DE EMISSÃO	JUSTIFICATIVA
Taxa de inscrição no evento International Comision on Glass Annual Meeting 2015	R$ 1.820,44	3/7/15	Taxa de inscrição para participação no Annual Meeting, International Commision on Glass, 20-23 setembro 2015, com apresentação de trabalho oral.
Taxa de inscrição - evento França	R$ 1.956,64	20/8/15	Para participar da conferência há a necessidade de se pagar a taxa de inscrição na mesma
Seguro Saúde - Atlanta/EUA	R$ 307,98	20/8/15	Seguro saúde para Prof. Edgar para participação do 14th International Conference on The Physics of Non-Crystalline Solids, no período de 19 a 27/09/2015 onde apresentou o trabalho intitulado “Crystal nucleation in glass-forming liquids revisited” em Niagara Falls, NY, USA.
Taxa de inscrição - evento Niagara Falls NY	R$ 2.180,79	7/10/15	Serviço de pagamento de taxa de inscrição para Prof. Edgar participação do 14th International Conference on The Physics of Non-Crystalline Solids, no período de 19 a 27/09/2015 onde apresentou o trabalho intitulado “Crystal nucleation in glass-forming liquids revisited” em Niagara Falls, NY, USA.
Seguro saúde GRU/CDG/LED/MAS/GRU	R$ 235,60	16/10/15	Participação convidada na Mesa Redonda "Prospects for International Scientific and Technical Cooperation -21st Century Challenge" e apresentação oral convidada "Bio glass and glass-ceramics for medical applications" no Interdisciplinary Youth Scientific Forum «New materials. Science days. Saint-Petersburg 2015», de 20 a 22/10/2015, além da apresentação oral convidada "Innovation at University of Sao Paulo and the Center for Research, Technology and Education in Vitreous Materials, Brazil" em sessão plenária do Forum "Innovation and technological cooperation in the field of chemistry for the development of the North-West region of Russia", 22 a 23/10/2015, no Institute of Silicate Chemistry da Russian Academy of Science, em St. Petersburg, Russia.
Taxa de inscrição no evento 11th International Symposium on Crystallization in Glasses and Liquids	R$ 932,10	21/10/15	Participação em congresso de interesse para as pesquisas desenvolvidas, com apresentaçãod e trabalho oral.

Apresentação de seção específica para aplicação dos recursos de Reserva Técnica
Processo 2013/07793-6 - Prestação de Contas Parcial

MATERIAL DE CONSUMO			
DESCRIÇÃO	**VALOR**	**DATA DE EMISSÃO**	**JUSTIFICATIVA**
Adaptador USB	R$ 59,00	03/06/2015	Adaptador USB para computador de laboratório
Filtro ar	R$ 203,00	30/06/2015	Manutenção da linha de ar comprimido seco do espectrômetro de RMN
Arame e cabo flexível	R$ 30,90	11/07/2015	Materiais para manutenção e ajustes de equipamentos do laboratório
Oxford tinto	R$ 1.056,51	11/07/2015	SBPC Jovem- utilização na Mostra de Divulgação Científica
Tonners	R$ 1.236,21	13/07/2015	São necessarios tonners para impressao de documentos relacionados a pesquisa!
Baterias e termo-ret	R$ 493,00	21/07/2015	Insumos utilizados em multimetros portátil do laboratório
Chaves allen e rebarbador	R$ 130,68	23/07/2015	Ferramentas comuns de uso em laboratório
Fonte ATX	R$ 52,00	28/07/2015	Fontex ATX para computador
Desinfetante, detergente, etc	R$ 687,55	29/07/2015	Material de limpeza necessário para manter a assepsia no Laboratório
Nereya, etc	R$ 176,50	12/08/2015	manutenção da rede elétrica do laboratório de fornos
Sifão, etc	R$ 17,60	12/08/2015	Manutenção de lavatórios do laboratório
Recipiente para lavagem de AL203	R$ 650,00	13/08/2015	Placa para proteção da base do porta-amostra de platina de DSC Netzsch contra a aderência de cadinhos de platina (amostra e referência).Obs. Não é "recipiente para lavagem". A tradução correta é "placa de proteção"
Arame e aluminio	R$ 49,44	20/08/2015	Confecção de peças de fornos de baixa temperratura do laboratório
Alumínio e inox	R$ 1.046,00	24/08/2015	Construção de dispositivo para colagem de fitas cerâmicas (tape-casting) para pesquisa e desenvolvimento de substratos e placas vitrocerâmicos para aplicações em eletrônica e outras, bem como de seu processo de fabricação.
Bucha, fico, etc	R$ 150,20	24/08/2015	Para instalação de acessório do microscópio confocal
Fonte e HD 1TB	R$ 415,64	25/08/2015	Materiais de informática para computadores do LaMaV
HD externo	R$ 298,75	26/08/2015	HD de back up de dados de RMN de uso de pesquisador principal
Cart. HP 21, tonner HP, etc.	R$ 843,32	26/08/2015	Cartucho de tinta HP21 utilizados na impressora Deskjet que se encontra no laboratório de Ressonância Magnética do IFSC/USP e cartucho de Toner utilizado nas impressoras Laser Jet. Estes cartuchos permitem a impressão em papel dos resultados dos estudos de espectroscopia de Ressonância Paramagnética Eletrônica (RPE) e a impressão dos artigos e relatórios do projeto Centro de Pesquisa, Inovação e Difusão CeRTEV
Lâmpada Flu Led Tube	R$ 230,00	31/08/2015	Substituição de lâmpadas queimadas do laboratório
Diesel	R$ 345,17	10/09/2015	Diesel para absstecimento de gerador de energia
Caneta, etiqueta e papel	R$ 97,01	10/09/2015	Organização do I Workshop Universidade-Empresa em Materiais Vítreos, realizado na Escola de Engenharia de São Carlos, USP, em 11/09/2016, com o objetivo de fazer prospecção sobre as demandas de ciência e tecnologia em vidros da indústria vidreira nacional e demais empresas interessadas em vidros.
Adere fita, norton lamina, etc	R$ 243,80	11/09/2015	Materiais para reparos diversos no laboratório
Spiral	R$ 301,91	15/09/2015	Spiral plástico para separação dos cabos de ligação do microscópio confocal
Tonner HP CB436A	R$ 240,00	24/09/2015	Tonner para impressora

Alumínio, etc	R$ 110,23	25/09/2015	Confecção de peças por usinagem necessárias para o laboratório
Cartuchos	R$ 60,00	09/10/2015	Cartuchos de tinta para impressora
DVD-R Philips e estojo acrilico	R$ 65,00	10/10/2015	Midia de back up de dados.
Torneira	R$ 116,95	21/10/2015	Manutenção de lavatórios do laboratório
Adapt, ferro solda e pistola de soldar	R$ 122,00	27/10/2015	Material usado para reposição de soldadores que estavam com defeito
Controle universal	R$ 45,00	28/10/2015	Controle universal para aparelho de ar condicionado
Toners	R$ 300,00	10/11/2015	Cartucho de toners para impressora
Garrafa térmica	R$ 131,28	16/11/2015	Para manter por longos períodos referência 0ºC em medidas de temperaturas
Memória DDR3	R$ 138,15	27/11/2015	Memória para computador
Botijão criogênico	R$ 2.600,00	30/11/2015	Dewar de 20 l para nitrogênio líquido de uso no laboratório de RMN
Motor de indução, redução para M425, variador de velocidade	R$ 1.114,00	02/12/2015	Construção de dispositivo para colagem de fitas cerâmicas (tape-casting) para pesquisa e desenvolvimento de substratos e placas vitrocerâmicos para aplicações em eletrônica e outras, bem como de seu processo de fabricação.
Aluminio chato	R$ 16,00	04/12/2015	Construção de dispositivo para colagem de fitas cerâmicas (tape-casting) para pesquisa e desenvolvimento de substratos e placas vitrocerâmicos para aplicações em eletrônica e outras, bem como de seu processo de fabricação.
Aparelho solda max-chama bico 1	R$ 49,06	05/12/2015	Um bico de chama de gás para serviços de vidraria no laboratório
Memoria DDR2 2GB Kingston	R$ 183,60	08/12/2015	pentes de memoria para reparo de um computador
Dessecador de Plastico	R$ 696,75	10/12/2015	Este dessecador será utilizado para armazenagem, tanto de matérias-primas (boro, carbonato de lítio e óxido de lantânio) como de vidros produzidos a partir delas, os quais possuem elevado grau de higroscopicidade. Desta forma, poderemos preservar as matérias -primas, bem como as amostras produzidas para futura caracterização
Disco d 203,2mm inox430 - 1mm/corte	R$ 700,92	11/12/2015	Construção de dispositivo para colagem de fitas cerâmicas (tape-casting) para pesquisa e desenvolvimento de substratos e placas vitrocerâmicos para aplicações em eletrônica e outras, bem como de seu processo de fabricação.
Módulo isolador moduline, fonte fortrek e mouse óptico	R$ 223,00	16/12/2015	Materiais de informática para computadores do LaMaV
Cabeçote micrométrico e desempeno de granito	R$ 1.246,00	16/12/2015	Construção de dispositivo para colagem de fitas cerâmicas (tape-casting) para pesquisa e desenvolvimento de substratos e placas vitrocerâmicos para aplicações em eletrônica e outras, bem como de seu processo de fabricação.
Luva, detergente, esponja, etc	R$ 746,07	21/12/2015	Material de limpeza necessário para manter a assepsia no Laboratório
Lustra móveis e saco alvejado	R$ 53,00	22/12/2015	Material de limpeza necessário para manter a assepsia no Laboratório
Adaptador BNC femea x femea painel LA 16	R$ 120,00	13/01/2016	Conector BNC-BNC para cabo coaxial para ser conectado em chassis de equipamentos
Saco zip hermetico	R$ 55,20	26/01/2016	Sacos plásticos com vedação para armazenamento de amostras e materiais de laboratório
BRM terr-neut, cont sie, disj weg, etc	R$ 896,66	02/02/2016	Cabos elétricos, contatores, relés térmicos, sensor de fase e conectores para instalação do acionamento elétrico do refrigerador dos eletroímãs do laboratório
Pino banana, cabo flex, etc.	R$ 85,00	04/02/2016	Conectores do tipo banana e fios para montagem de circuitos elétricos no laboratório
Teclado, bateria CR2032, bateria 9V, etc.	R$ 223,00	04/02/2016	O fluorimetro deve ficar em ambiente resfriado, de acordo com a recomendação do fabricante. Alem disso, os alunos e pesquisadores que trabalham diretamente no laboratorio necessitam respirar ar salubre, daí a necessidade de higienizar os equipamentos de a

metalon 30x30x1,50, ferro chato, etc.	R$ 209,63	12/02/2016	Material para construção de carro de translado e basculante do Dewar de 20l.
Relé termico p/ bomba d' água	R$ 64,46	20/02/2016	Um relé térmico para montagem do sistema de refrigeração dos eletroímãs
Teclado Maxprint e mouse op.	R$ 54,30	24/02/2016	Um teclado e um mouse para computador do laboratório
Vareta tig inox novametal	R$ 89,89	01/03/2016	Materiais para soldagem de perfil aço inodixável
Cabo HDMI / micro HDMI Elgin	R$ 21,13	01/03/2016	Despesas relativas a busca de anterioridade de patente e taxa para depósito de pedido de patente
Cabo PP IFC 3x, lampada led, etc.	R$ 174,63	05/03/2016	Cabos elétricos para montagem do sistema de refrigeração dos eletroímãs e lâmpada para iluminação do local
Papel sulfite A4	R$ 160,00	08/03/2016	Papel A4 para impressão de documentos entre outros
Pen Drive 8GB MAXPRINT	R$ 18,77	09/03/2016	Um disco tipo SD para o controlador do forno (Arduino).
Cobre e aluminio	R$ 159,78	11/03/2016	Chapa fina de cobre como condutor elétrico com ligação com os perfis de alumínio
Bari tom, CB 750V, cx plástica, etc	R$ 1.573,62	17/03/2016	Redimensionamento elétricos de três laboratórios
Bateria 12V unipower	R$ 848,40	22/03/2016	Troca das baterias dos No-Break do Clusters do Laboratorio de Simulação
Regulador de pressão	R$ 158,00	24/03/2016	Regulador de pressão marca Norgren R07-200-RNKA, entrada 300psi/21bar, saída 100psi/6.9bar. Regulador de agulha de precição para ar comprimido, para controle da rotação das amostras nos experimentos de RMN de alta resolução. Peça de reposição instalada no espectrômetro de RMN, subtituindo a original que quebrou
Funil, filtro, chave, etc	R$ 474,00	24/03/2016	Para transferir diesel no tanque do gerador
Daisa uni preto, GLV el abrac, etc.	R$ 51,51	26/03/2016	Material para montagem da estrutura para realização de mostra do Mundo de Vidro no Espaço Ventura
Galão de 50 lts e evolux diesel	R$ 251,30	28/03/2016	Diesel para absstecimento de gerador de energia
STP SC diesel fuel injector	R$ 270,00	28/03/2016	Diesel para absstecimento de gerador de energia
Arruela, parafuso, etc.	R$ 312,94	29/03/2016	rodízios para caixas de transporte da exposição de vidro, entre outros
Evolux diesel	R$ 156,33	29/03/2016	Diesel para absstecimento de gerador de energia
EXT PL 3X0,75MM 5MT CZ NO SHOCK	R$ 25,00	30/03/2016	Materiais elétricos para confecção de circuitos eletrônicos
Granito cinza corumbá	R$ 86,40	13/04/2016	Tampo de granito para instalação de máquina de ensaio mecânico
Sintético branco	R$ 28,00	14/04/2016	Tinta automotiva para pintura de suporte basculante móvel para dewar de nitrogênio líquido, utilizado no laboratório de RMN.
HD Ide Maxtor Ata/133 HD	R$ 19,90	14/04/2016	HD antigo para operar o Forno gradiente
Cilindros agata 18x8mm	R$ 439,00	20/04/2016	Estes cilindros de ágata serão utilizados para moagem e homogeneização dos reagentes para a produção dos vidros, bem como a moagem de vidros de bioativos, os quais não podem ser triturados com alumina e/ou zircônia (normalmente utilizados como meio de moagem em processamento cerâmico convencional) devidop ao risco de contaminação
Frasco de boca larga, tampa rosca	R$ 303,30	20/04/2016	Os frascos serão utilizados como recipientes para os cilindros de ágata no processo de moagem/homogeneização de matérias-primas e dos vidros bioativos
Metalon, ponteira ret	R$ 151,85	26/04/2016	Material para montagem da estrutura para realização de mostra do Mundo de Vidro no Espaço Ventura
Perfil de aluminio, dobradiça, conector universal, etc.	R$ 1.239,39	27/04/2016	Construção de dispositivo para colagem de fitas cerâmicas (tape-casting) para pesquisa e desenvolvimento de substratos e placas vitrocerâmicos para aplicações em eletrônica e outras, bem como de seu processo de fabricação.
Pilha palito duracell, refil elem filt carvão	R$ 46,67	28/04/2016	Insumos para materiais eletronicos

Engenharia cristal incolor 8mm	R$ 175,00	28/04/2016	Construção de dispositivo para colagem de fitas cerâmicas (tape-casting) para pesquisa e desenvolvimento de substratos e placas vitrocerâmicos para aplicações em eletrônica e outras, bem como de seu processo de fabricação.
Led, cabo espaguete, diodo, chave enroladeira, mosfet	R$ 97,53	07/05/2016	Materiais elétricos para confecção de circuitos eletrônicos
Porta cerveja, caixa adaptadora, bandeja plastica, etc.	R$ 69,11	07/05/2016	2 Recipientes de isopor ("porta cerveja") para transporte de pequenas quantidades de nitrogênio líquido no laboratório de RMN. - 1 Caixa adaptadora com divisões para estocagem dos rotores porta-amostras e acessórios da sonda de RMN (rotores, tampas ferramentas de precisão para empacotamento de material analisado).
Loctite super bonder, fita veda rosca, parafuso madeira, bucla plast., etc.	R$ 200,00	19/05/2016	Materiais necessários para manutenção e reparos de equipamentos e peças do laboratório
Luva latex, esponja brilhos, toalha de papel, etc.	R$ 1.159,00	20/05/2016	Material de limpeza necessário para manter a assepsia no Laboratório
Diesel fuel injector cleaner	R$ 405,00	02/06/2016	Diesel para absstecimento de gerador de energia
Diesel	R$ 220,02	03/06/2016	Diesel para absstecimento de gerador de energia
Conexão e luva	R$ 17,48	31/07/2015	Manutenção da linha de ar comprimido seco do espectrômetro de RMN
Rack para TV LCD	R$ 1.300,00	08/07/2015	Suporte para TV utilizada nos eventos SBPC, SNCT e Circo da Ciência
Cartuchos, toners e papel	R$ 843,31	06/08/2015	Cartuchos de tinta utilizados na impressora Deskjet do próprio pesquisador e na impressora do mesmo tipo que se encontra no laboratório de Ressonância Magnética do IFSC/USP. O cartucho de Toner é utilizado na impressora Laser Jet do pesquisador. Estes cartuchos permitem a impressão em papel dos resultados dos estudos de espectroscopia de Ressonância Paramagnética Eletrônica (RPE) e a impressão dos artigos e relatórios.
Fonte ATX	R$ 210,00	14/09/2015	Manutenção de fonte de alimentação de computador de alunos
Suportes para prateleira	R$ 157,40	16/03/2016	Suportes de ferro do tipo “mão francesa” para confecção de prateleiras no laboratório

SERVIÇO DE TERCEIROS

DESCRIÇÃO	VALOR	DATA DE EMISSÃO	JUSTIFICATIVA
Carro	R$ 1.133,50	24/07/2015	Despesas de viagem com carro oficial do IFSC-USP de São Carlos – Goiânia – São Carlos, para intercâmbio científico
Dutotec, etc	R$ 1.594,95	25/05/2015	Manutenção da rede elétrica do laboratório de fornos
Correios	R$ 34,80	03/06/2015	Envio de documentos
Higienização Split	R$ 1.220,00	03/06/2015	Limpeza de ar condicionados da sala do espectrômetro de RMN
Correios	R$ 188,00	12/06/2015	Serviço solicitado para envio de cartas para vistos para alunos estrangeiros que participaram do Advanced School on Glasses and Glass Ceramics, Sao Carlos - SP, Agosto de 2015, devido método rápido dos correios
Correios	R$ 17,30	22/06/2015	Envio de amostras para pesquisa
Correios	R$ 27,80	22/06/2015	Envio de amostras para pesquisa
Correios	R$ 94,00	02/07/2015	Serviço solicitado para envio de cartas para pedido de vistos para alunos estrangeiros que participaram do Advanced School on Glasses and Glass Ceramics, Sao Carlos - SP, Agosto de 2015, devido método rápido dos correios

Despesa com transporte de alunos, etc	R$ 810,00	06/07/2015	EFEM (Escola de férias de engenharia de materiais (40 alunos do ensino médio). A atividade é coordenada pelo Prof. Piter Gargarella e sou membro da organização. O CeRTEV entrou como "patrocinador"/co-organizador do evento (o qual tb será feito este ano no dia 11,12 e 13/07.
Despesa com transporte de alunos, etc	R$ 600,00	06/07/2015	ACIEPE (transporte dos alunos de graduação e equipamentos para as atividades na escola - ensino fundamental)
Viagens	R$ 1.113,00	07/07/2015	Apresentações teatrais em São Carlos
Correios	R$ 17,30	13/07/2015	Envio de amostras para pesquisa
Cartaz, gibis, etc	R$ 2.953,00	14/07/2015	impressão de cartazes do projeto Semear Ciência e mangás de Histórias de vidro em quadrinhos
Submissão de artigo	R$ 904,11	14/07/2015	Submissão de artigo entitulado "Decoupling of crystal growth kinetics an viscosity in diopside" no American Journal Experts
Posters fotográfico	R$ 280,00	20/07/2015	Impressão de poster para participação de congresso
Transporte de pesquisador visitante	R$ 550,00	20/07/2015	Transporte para receber Prof. Prabhat Gupta pesquisador visitante no aeroporto de Guarulhos - SP
Idealização de layout e execução	R$ 900,00	28/07/2015	Arte dos cartazes do projeto Semear Ciência
Viagem dentro de São Carlos	R$ 510,00	05/08/2015	Apresentação teatral- Grupo Ouroboros
Pôster	R$ 35,00	05/08/2015	Impressão de poster para participação no Advanced School on Glasses and Glass Ceramics, Sao Carlos - SP, Agosto de 2015
Pôster	R$ 35,00	05/08/2015	Impressão de poster para participação no Advanced School on Glasses and Glass Ceramics, Sao Carlos - SP, Agosto de 2015
Pôster	R$ 35,00	05/08/2015	Impressão de poster para participação no Advanced School on Glasses and Glass Ceramics, Sao Carlos - SP, Agosto de 2015
Pôster	R$ 35,00	05/08/2015	Impressão de poster para participação no Advanced School on Glasses and Glass Ceramics, Sao Carlos - SP, Agosto de 2015
Pôster	R$ 35,00	05/08/2015	Impressão de poster para participação no Advanced School on Glasses and Glass Ceramics, Sao Carlos - SP, Agosto de 2015
1 painel	R$ 47,00	06/08/2015	Organização do I Workshop Universidade-Empresa em Materiais Vítreos, realizado na Escola de Engenharia de São Carlos, USP, em 11/09/2016, com o objetivo de fazer prospecção sobre as demandas de ciência e tecnologia em vidros da indústria vidreira nacional e demais empresas interessadas em vidros.
Seguro saúde - SP/Detroit/SP	R$ 184,08	07/08/2015	Participação em reunião técnica no período de 09 a 12/08/2015 na sede da Owens-Illinois, em Perrysburg, OH - USA
Submissão do artigo Bioactive Glass-ceramics	R$ 909,98	20/08/2015	Submissão de artigo entitulado "Bioactive Glass-ceramics" no Journal American Experts
Correios	R$ 18,50	26/08/2015	Envio de cópias de cadernos de usuários de quipamento MEV PHENOM
Cópias MEV PHENOM	R$ 19,80	26/08/2015	Cópia de caderno de usuários de equipamento MEV PHENOM
Submissão de artigo Effect of elastic stresses on the thermodynamic barrier for crystal nucleation	R$ 933,69	31/08/2015	Submissão de artigo entitulado "Effect of elastic stresses on the the modynamic barrier for crystal nucleation" no Journal American Experts
Usinagem em dispositivo	R$ 250,00	01/09/2015	Construção de dispositivo para colagem de fitas cerâmicas (tape-casting) para pesquisa e desenvolvimento de substratos e placas vitrocerâmicos para aplicações em eletrônica e outras, bem como de seu processo de fabricação.
Correios	R$ 51,80	02/09/2015	Envio de amostras do prof. Edgar para prof. Francisco Serbena da UEPG e para prof. Gelson da UNESP Araraquara
Impressões e encadernações	R$ 31,25	02/09/2015	Impressões e encadernações de documentos
Correios	R$ 38,05	04/09/2015	Postagem de documentos para IMPA e Grã-Bretanha

Serviço de impressões	R$ 477,90	10/09/2015	Organização do I Workshop Universidade-Empresa em Materiais Vítreos, realizado na Escola de Engenharia de São Carlos, USP, em 11/09/2016, com o objetivo de fazer prospecção sobre as demandas de ciência e tecnologia em vidros da indústria vidreira nacional e demais empresas interessadas em vidros.
Arotec Ind. e Com. S.A.	R$ 257,98	18/09/2015	Transporte de transdutor Arotec Pulso ECO
Despesa com transporte do pesquisador	R$ 555,08	18/09/2015	Transporte do Prof. Edgar do aeroporto no dia 13/08/2015 que retornou de participação em reunião técnica no período de 09 a 12/08/2015 na sede da Owens-Illinois, em Perrysburg, OH - USA
Correios	R$ 34,80	24/09/2015	Envio de amostras para pesquisa
Serviços de manutenção corretiva em forno elétrico	R$ 2.000,00	25/09/2015	O aquecedor queimou tivemos que jogar fora e substituí-lo
Correios	R$ 22,30	28/09/2015	Envio de documentos
Correios	R$ 19,30	28/09/2015	Envio de documentos para prof. Marcelo Nalin na UNESP de Araraquara-SP
Posters	R$ 65,00	02/10/2015	Impressão de poster para participação de congresso
Manutenção corretiva de forno elétrico	R$ 3.300,00	06/10/2015	O aquecedor queimou tivemos que jogar fora e substituí-lo
Manutenção em computador	R$ 530,00	06/10/2015	Manutenção e reparo em computador
Seguro saúde para participação no 11th International Symposium on Crystallization in Glass and Liquid	R$ 321,36	07/10/2015	Participação em congresso de interesse para as pesquisas desenvolvidas, com apresentaçãod e trabalho oral.
Correios	R$ 37,60	08/10/2015	Enviado para Profa.Viviane O. Soares, Universidade Estadual de Maringá - Amostras de vidro nanométrico para eletrofiação
Suporte técnico, manutenção e outros serviços	R$ 192,50	09/10/2015	Manutenção de computador do equipamento Horiba
Correios	R$ 141,80	16/10/2015	Postagem para envio de amostras ao Prof. Dr. Leo van Wullen - Alemanha
Correios	R$ 17,30	21/10/2015	Envio de amostras para pesquisa
Manutenção impressora HP	R$ 994,00	27/10/2015	Manutenção de impressora HP utilizada por alunos de IC e pós-graduação para impressão de documentos no âmbito do CeRTEV.
Cerâmica refratária	R$ 400,00	27/10/2015	Injeção de vitrocerâmicas disilicato de lítio para ensaio mecânico
Suporte, manutenção e hospedagem do site	R$ 400,00	28/10/2015	Serviços relacionados ao site da educação: www.vidro.ufscar.br
Eixo para centramento de amostra	R$ 100,00	29/10/2015	Alteração do dispositivo de ensaio mecânico de flexão de discos cerâmicos
Correios	R$ 83,00	29/10/2015	Envio de documentos para EUA
Correios	R$ 110,00	06/11/2015	Envio de documentos para Itália
Montagem de sistemas de controle de atmosfera	R$ 1.570,00	10/11/2015	Devido a derrame de um vidro formando derrete, o interior de um forno tinha que remodelado
Correios	R$ 17,30	11/11/2015	Envio de amostras para pesquisa
Impressões	R$ 116,25	13/11/2015	Impressão de poster dissertação de mestrado para entrega banca
Transporte de estante	R$ 111,31	16/11/2015	Transporte de vitrine de vidro para exposição de galeria de vidros do Laboratório
Taxa de inscrição em curso de Espectroscopia de Impedância Eletroquímica Adriana Muñoz	R$ 550,00	17/11/2015	Taxa de inscrição em curso sobre espectroscopia de imepedancia, técnica esta utilizada pela bolsista Adriana Nieto Muñoz, conforme SM38
Taxa de inscrição em curso de curso de Espectroscopia de Impedância Eletroquímica Jairo Felipe	R$ 550,00	17/11/2015	Taxa de inscrição em curso sobre espectroscopia de imepedancia, técnica esta utilizada pelo bolsista Jairo Felipe Ortiz, conforme SM38
Impressões e encadernações	R$ 100,95	19/11/2015	Impressão de poster qualificação de doutorado para entrega banca
Correios	R$ 51,00	23/11/2015	Envio de amostras do prof. Oscar Peitl para Goiânia

Submissão de artigo	R$ 840,17	26/11/2015	Serviço de submissão de artigo entitulado "The effect of P205 on non-isothermal sinte crystallization process of a multicomponent lithium aluminum silicate lass" no American Journal Experts
Pôster em lona	R$ 357,00	27/11/2015	Impressão de posteres para participações em congressos
Correios	R$ 26,85	02/12/2015	Envio de cadinhos para serem reformados na empresa Heraeus Vectra
Correios	R$ 210,00	02/12/2015	Envio de documentos para França
impressões coloridas	R$ 288,00	02/12/2015	Serviços de impressões documentos
Despesa com transporte dos pesquisadores Gabriel, Leonardo e Mariana	R$ 630,05	09/12/2015	Despesa de transporte para doutorando e pós doc do LaMaV realizerm reunião no CTA em São José dos Campos
Despesa com transporte do pesquisador Prabhat Gupta	R$ 511,80	09/12/2015	Transporte de pesquisador visitante
Despesa com transporte do pesquisador	R$ 363,28	09/12/2015	Transporte do Prof. Edgar do aeroporto no dia 28/09/2015
Despesa com transporte dos pesquisadores Shiv e Edgar	R$ 532,50	09/12/2015	Transporte do Prof. Edgar e Dr. Shiv Singh para aeroporto no dia 18/09/2015 para participação no 14th International Conference on The Physics of Non-Crystalline Solids, no período de 19 a 27/09/2015 onde apresentei uma palestra como convidado (invited talk), intitulada “Crystal nucleation in glass-forming liquids revisited” em Niagara Falls, NY, USA
Despesa com transporte do pesquisador	R$ 497,92	09/12/2015	Transporte do Prof. Edgar no dia 08/10/2015 que ministrou palestra intitulada “LaMav: 40 anos de Ciência e Tecnologia de Vidros”, 17º Congresso de Tecnologia, 17º Simpósio de Iniciação Científi ca e Tecnológica, realizado na FATEC no período de 05 a 08/10/2015 em São Paulo-SP
Despesa com transporte do pesquisador	R$ 551,60	09/12/2015	Transporte do Prof. Edgar do aeroporto de Guarulhospara São Carlos-SP no dia 20/11/2015 onde participou de reunião técnica no período de 16 a 20/11/2015 na sede da Owens-Illinois, em Perrysburg, OH - USA
Despesas com transportes de pesquisadores (Profs Guillermo e Eglantina)	R$ 1.185,00	10/12/2015	Transporte dos pesquisadores Prof. Dr. Guillermo Gonzalez e a Profa. Dra. Eglantina Benavente do Grupo de “Química dos Compostos de Intercalação”, Facultad de Ciencias, Universidad de Chile, na visita realizada ao Instituto de Física de São Carlos, USP, de 24 a 29 de agosto, 2015. Estes pesquisadores fazem parte da relação de colaboradores estrangeiros do projeto Centro de Pesquisa, Inovação e Difusão CeRTEV (Fapesp Proc. 2013/07793-6). Esta visita se insere dentro da colaboração científica entre nossos grupos, no qual participam também o Prof. Dr. Claudio J. Magon e a Profa. Andrea S.S. de Camargo, pesquisadores do CeRTEV. Nesta visita do Prof. Gonzalez e da Profa. Benavente discutimos os resultados dos estudos em andamento no IFSC utilizando a técnica de Ressonância Paramagnética Eletrônica
Despesas com transportes de pesquisadores (diferença do projeto da Escola - Profs Guillermo e Eglantina)	R$ 255,00	10/12/2015	Despesas de transporte de pesqusiador
Correios	R$ 103,00	10/12/2015	Transporte entre São Carlos e aeroporto de Guarulhos Para o Prof. Visitante Jean-Louis Souquet
Despesa com transporte dos pesquisadores Leonardo e Mariana	R$ 616,08	10/12/2015	Despesa de transporte para doutorando e pós doc do LaMaV realizerm reunião no CTA em São José dos Campos
Despesa com transporte do pesquisador Jean Souquet	R$ 595,84	10/12/2015	Despesa de transporte para pesquisador visitante estrangeiro
Despesa com transporte do pesquisador Alexander Priven	R$ 573,00	10/12/2015	Despesa de transporte para pesquisador visitante estrangeiro

Despesa com transporte do pesquisador	R$ 516,82	10/12/2015	Transporte do Prof. Edgar de São Carlos-SP até o aeroporto de Guarulhos no dia 16/11/2015 onde participou de reunião técnica no período de 16 a 20/11/2015 na sede da Owens-Illinois, em Perrysburg, OH - USA
Correios	R$ 71,40	11/12/2015	Envio de documentos
Correios	R$ 17,30	14/12/2015	Envio de documentos
Correios	R$ 32,70	15/12/2015	Envio de amostras da Profa. Ana Candida para senhor Eudésio Vilar
Desenvolvimento e criação do site e de cartazes	R$ 600,00	17/12/2015	Projeto Semear Ciência e site educação: www.vidro.ufscar.br
Manutenção e higienização de ar condicionado	R$ 2.100,00	18/12/2015	O fluorimetro deve ficar em ambiente resfriado, de acordo com a recomendação do fabricante. Alem disso, os alunos e pesquisadores que trabalham diretamente no laboratorio necessitam respirar ar salubre, daí a necessidade de higienizar os equipamentos de ar condicionado.
Despesas relativas a busca de anterioridade de patente e taxa para depósito de pedido de patente	R$ 1.222,32	23/12/2015	Despesas relativas a busca de anterioridade de patente e taxa para depósito de pedido de patente
Despesa com transporte do pesquisador Leonardo Gallo	R$ 317,28	06/01/2016	Despesa de transporte para doutorado realizar reunião e pesquisa científica no LNN - Laboratório Nacional de Nanotecnologia em Campinas-SP
Substituição de bomba d'água	R$ 3.023,00	12/01/2016	Foi trocada a bomba d'agua de uma evaporadora de canhão de elétrons que possuimos no laboratório. o equipamento é utilizado para produzir filmes finos vítreos usando como material de partida os vidros preparados no laboratório. os materiais preparados por essa técnica são usados em estudos de propriedades ópticas
Correios	R$ 154,00	16/01/2016	Envio de documentos para Itália
Correios	R$ 36,90	22/01/2016	Envio de amostras para pesquisa
Correios	R$ 17,30	27/01/2016	Envio de amostras para pesquisa
Desenvolvimento e criação do site e de cartazes	R$ 900,00	27/01/2016	Projeto Semear Ciência e site educação: www.vidro.ufscar.br
Despesa com transporte do Prof. EDZ para Ribeirão Preto	R$ 218,60	28/01/2016	Transporte do Prof. Edgar até o aeroporto de Ribeirão Preto-SP no dia 10/01/2016 para realizar visita técnica no período de 10 a 17/01/2016 ao Departamento de Física da Universidade do Chile, e discutir projetos de pesquisa e conjunto com o Prof. Fernando Lund e apresentação de aulas
Correios	R$ 25,90	03/02/2016	Envio de amostras para pesquisa
Transpote de vitrines	R$ 280,05	12/02/2016	Transporte de vitrines de vidro para exposição de galeria de vidro do LaMaV
Serviço de beneficiamento em cadinhos	R$ 3.200,00	23/02/2016	Reparação e remanufatura de cadinhos de platina, reutilizando o material antigo
Manutenção em forno tipo Pan	R$ 1.225,00	24/02/2016	É refere a troca da resistência e manutenção de um forno usado para a preparação de vidros usando tubos de platina. a utilização deste forno muitas vezes necessita ser em temperaturas altas por várias horas, este procedimento diminuio tempo de vida das resistências, e eventualmente elas podem se romper e precisam ser trocadas
Despesa com o transporte dos pesquisadores Sr. Shingo e Sra. Yamashita	R$ 564,20	24/02/2016	Despesa de transporte com visitantes estrangeiros
Despesa comtransporte dos pesquisadores Sr. Maziar e Sra. Mina	R$ 601,60	24/02/2016	Despesa com transporte do pós doutorando Maziar Montazerian e sua esposa
Serviço ref. a substituição de turbina e do motor de um ar condicionado	R$ 800,00	26/02/2016	Foi necessario a aquisicao de um novo monitor para que o Prof. Raja Junaid - bolsista FAPESP pudesse ter um microcomputador disponibilizado a seu uso.
Desenvolvimento de software educativo e tecnológico	R$ 5.000,00	03/03/2016	Desenvolvimento de software educativo e tecnológico para reformulação de massas cerâmicas e vidros
Instalação de câmera e configuração de DVR	R$ 120,00	07/03/2016	Instalação de câmeras de segurança no Laboratório
Instalação e retirada painéis metrô	R$ 5.788,00	09/03/2016	Projeto Semear Ciência: despesas logísticas

Inscrição GOMD 2016	R$ 2.223,10	09/03/2016	Serviço de pagamento de taxa de inscrição do prof. Edgar para participação do Glass & Optical Materials Division Meeting 2016" no período de 18 a 28/05/16 , onde apresentou trabalho científico intitulado "A random walk through Don Uhlmann's crystallization research" , em Madison, WI USA.
Troca do motor ventilador do desumificador	R$ 210,00	10/03/2016	O motor do ventilador do desumidificador queimou e foi necessario realizar a sua troca.
assintência técnica em notebooks	R$ 1.239,00	12/03/2016	Manutenção em Notebook utilizado no LaMaV
Submissão de artigo	R$ 954,73	14/03/2016	Serviço de submissão de artigo entitulado "Crystal nucleation in gl ss-forming liquids: Effect of the size of the "structural units" no American Journal Experts
Submissão de artigo	R$ 1.089,26	14/03/2016	Serviço de submissão de artigo entitulado "Double layered nerve guide contai ing highly bioactive glass fibers" no American Journal Experts
Manutenção no banner do site	R$ 180,00	15/03/2016	serviços relacionados ao site da educação: www.vidro.ufscar.br
Cartaz	R$ 1.968,84	17/03/2016	impressão de cartazes do projeto Semear Ciência
Taxa de Inscrição Congresso Shangai/China (Caio B. Bragatto)	R$ 1.556,48	28/03/2016	Taxa de Inscrição Congresso Shangai/China (Caio B. Bragatto)
Depósito de patentes	R$ 41.031,13	30/03/2016	Despesa de depósito de pedido de patente junto ao INPI intitulado "Compósitos biomiméticos compreendendo alto teor de carga à base de quitosana e biocerâmica, processo para preparação dos ditos compósitos e seu uso em engenharia de tecidos"
manutenção sistema de refrigeração	R$ 600,00	05/04/2016	Serviço de manutenção e revitalização de um segundo refrigerador utilizado como backup
Correios	R$ 18,40	05/04/2016	Envio de amostras de Prof. Edgar para Prof. Gelson em Araraquara-SP
Manutenção em computador	R$ 20,00	11/04/2016	Manutenção em computador do LaMaV
Plasttotal plásticos industriais	R$ 78,49	13/04/2016	Transporte de placas de acrílico e PEAD que foram compradas com a empresa Plasttotal
Submissão de artigo	R$ 763,27	19/04/2016	Serviço de submissão de artigo entitulado "Sctructural and dynamic propertie of vitreous and crystalline barium disilicate: Molecular dynamics sim lation and Raman scattenng experiments" no American Journal Experts
Taxa de inscrição no 24th international Congress on Glass	R$ 2.820,60	19/04/2016	Taxa de inscrição no 24th international Congress on Glass
Inscrição 60º Congresso Brasileiro de Cêramica - Norma Machado	R$ 400,00	19/04/2016	Inscrição 60º Congresso Brasileiro de Cêramica - Norma Machado
Transporte da pesquisador Edgar Zanotto e Luciana Zanotto	R$ 615,60	25/04/2016	Transporte do Prof. Edgar e Sra. Luciana do aeroporto de Guarulhospara São Carlos-SP no dia 12/04/2016 onde participou do "24th International Congress on Glass" no período de 03 a 12/04/16 para apresentação de trabalho intitulado "Creation of a Glass Technician Training Course in Brazil" em Shanghai, China
Transporte do prof.º Edgar p/ SP em 03/04/16	R$ 543,24	25/04/2016	Transporte do Prof. Edgar e Sra. Luciana de São Carlos-SP até o aeroporto de Guarulhos no dia 12/04/2016 onde participou do "24th International Congress on Glass" no período de 03 a 12/04/16 para apresentação de trabalho intitulado "Creation of a Glass Technician Training Course in Brazil" em Shanghai, China
Inscrição 60º Congresso Brasileiro de Cêramica - Swarup Kundu	R$ 1.040,00	26/04/2016	Inscrição 60º Congresso Brasileiro de Cêramica - Swarup Kundu

Inscrição 60º Congresso Brasileiro de Cêramica - Ricardo Lancelotti	R$ 400,00	27/04/2016	Serviço de pagamento de taxa de inscrição de aluno de iniciação científica Ricardo Lancelotti para participação do 60º Congresso Brasileiro de Cerâmica, onde apresentou poster entitulado "MEDIDAS EXPERIMENTAIS DE CRESCIMENTO DE CRISTAIS EM TEMPERATURAS PRÓXIMAS À TG" no período de 15 a 18/05/2016 em Águas de Lindóia-SP
Inscrição 60º Congresso Brasileiro de Cêramica - Vinicius Torres	R$ 400,00	27/04/2016	Serviço de pagamento de taxa de inscrição de aluno de iniciação científica Vinicius Torres para participação do 60º Congresso Brasileiro de Cerâmica, onde apresentou poster entitulado "DESENVOLVIMENTO E CARACTERIZAÇÃO DE CÓMPÓSITOS BIOMIMÉTICOS' À BASE DE QUITOSANA E BIOCERÂMICAS MICRO E NANOPARTICULADAS" no período de 15 a 18/05/2016 em Águas de Lindóia-SP
Limpeza ar condicionado	R$ 440,00	28/04/2016	Esta empresa foi contratada para realizar a limpeza e higienização de um aparelho de ar condicionado na sala do pesquisador, no Instituto de Física de São Carlos (IFSC/USP). Este aparelho estava sem manutenção há vários anos, com grande risco de vazar água para dentro da sala do pesquisador
correios	R$ 142,00	05/05/2016	Envio de amostras de biosilicato para Sheffield
Transporte do prof.º Oscar de São Carlos/São Bernardo do Campo	R$ 607,20	06/05/2016	Transporte para Prof. Oscar participar reunião com discussão sobre o andamento do projeto relacioando ao processo de patente "Desenvolvimento e caracterização de compósitos biomiméti os com alto teor de carga à base de quitosana/Biosilicato® para aplicação na engenharia de tecidos" em colaboração UFSCar e UFABC.
Submissão de artigo	R$ 1.035,49	11/05/2016	Serviço de submissão de artigo entitulado "On the First Patents, Key Inventio s and Research Manuscripts about Glass Technology" no American Journal Experts
Inscrição 60º Congresso Brasileiro de Cêramica - Laura Mathias	R$ 400,00	11/05/2016	Inscrição 60º Congresso Brasileiro de Cêramica - Laura Mathias
Inscrição 60º Congresso Brasileiro de Cêramica - Nickson Ribeiro	R$ 400,00	12/05/2016	Serviço de pagamento de taxa de inscrição de aluno de iniciação científica Nickson Ribeiro para participação do 60º Congresso Brasileiro de Cerâmica, onde apresentou posteres entitulados "BIOATIVIDADE IN VITRO E ATIVIDADE ANTIMICROBIANA DE VIDROS E VITROCERÂMICAS CONTENDO íONS COM AÇÃO BIOLÓGICA" e "AVALIAÇÃO DA BIOATIVIDADE IN VITRO DO BIOSILlCATO®' UTILIZANDO O MÉTODO TC04 DESENVOLVIDO PARA MATERIAIS PARTICULADO" no período de 15 a 18/05/2016 em Águas de Lindóia-SP
Painel Gloos Paper	R$ 47,00	17/05/2016	Organização do I Workshop Universidade-Empresa em Materiais Vítreos, realizado na Escola de Engenharia de São Carlos, USP, em 11/09/2016, com o objetivo de fazer prospecção sobre as demandas de ciência e tecnologia em vidros da indústria vidreira nacional e demais empresas interessadas em vidros.
Seguro Saúde	R$ 155,00	18/05/2016	Seguro saúde para participação do Glass & Optical Materials Division Meeting 2016” no período de 18 a 28/05/16 , onde apresentou trabalho científico intitulado “A random walk through Don Uhlmann’s crystallization research” , em Madison, WI USA.

correios	R$ 18,10	19/05/2016	Envio de amostras para Prof. Gelson em Araraquara-SP
Soldas em estrutura em inox	R$ 180,00	19/05/2016	Serviço de soldagem para confecção de estrutura de cantoneira em inoxidável
5 posters em lona	R$ 242,40	24/05/2016	Impressão de posteres a serem apresentados no 60º Congresso Brasileiro de Cêramica - Laura Mathias
5 posters em lona e 2 em tecido	R$ 345,00	24/05/2016	Serviço de impressão de posteres para participação em congressos científicos
Análises por difração de raios-x	R$ 300,00	01/06/2016	Difração de raios-X de amostras de vidro tratadas para cristalização, visando a determinação das fases cristalinas presentes ou da natureza vítrea das mesmas.

DIÁRIAS

DESCRIÇÃO	VALOR	DATA DE EMISSÃO	JUSTIFICATIVA
Diárias - Seoul/São Carlos/Seoul - Alexander Priven	R$ 1.600,00	16/8/15	O Dr. Priven ministrou um mini-curso a todos integrantes do LaMaV sobre o uso do software e base de dados SCIGLASS
Diárias 24/08 a 29/08/15 - Guillermo Moraga	R$ 1.600,00	17/8/15	Pagamento de diárias para financiar a estadia do Prof. Dr. Guillermo Gonzalez Moraga do Grupo de "Química dos Compostos de Intercalação", Facultad de Ciencias, Universidad de Chile, na visita realizada de 24 a 29 de agosto, 2015. Este pesquisador faz parte da relação de colaboradores estrangeiros do projeto Centro de Pesquisa, Inovação e Difusão CeRTEV (Fapesp Proc. 2013/07793-6). Esta visita se insere dentro da colaboração científica entre nossos grupos, no qual participam também o Prof. Dr. Claudio J. Magon e a Profa. Andrea S.S. de Camargo, pesquisadores do CeRTEV. Nesta visita discutimos os resultados dos estudos em andamento no IFSC utilizando a técnica de Ressonância Paramagnética Eletrônica
Diárias 24/08 a 29/08/15 - Eglantina Espinosa	R$ 1.600,00	17/8/15	Pagamento de diárias para financiar a estadia da Profa. Dra. Eglantina Espinoza do Grupo de "Química dos Compostos de Intercalação", Facultad de Ciencias, Universidad de Chile, na visita realizada de 24 a 29 de agosto, 2015. Esta pesquisadora faz parte da relação de colaboradores estrangeiros do projeto Centro de Pesquisa, Inovação e Difusão CeRTEV (Fapesp Proc. 2013/07793-6). Esta visita se insere dentro da colaboração científica entre nossos grupos, no qual participam também o Prof. Dr. Claudio J. Magon e a Profa. Andrea S.S. de Camargo, pesquisadores do CeRTEV. Nesta visita discutimos os resultados dos estudos em andamento no IFSC utilizando a técnica de Ressonância Paramagnética Eletrônica
Diárias/Perrysburg 09/08 a 12/08/15	R$ 1.758,75	28/8/15	Participação em reunião técnica no período de 09 a 12/08/2015 na sede da Owens-Illinois, em Perrysburg, OH - USA
Diária São Paulo/São Carlos/São Paulo - Signo Tadeu dos Reis	R$ 320,00	31/8/15	O Dr. Signo Reis - pesquisador dos EUA ministrou um seminário sobre Special glasses sobre SOFC applications e passou dois dias em São Carlos discutindo possíveis projetos em colaboração
Diárias - SC/SP/SC SM 38	R$ 430,00	9/10/15	Participação em curso sobre espectrocopia de imepedancia, técnica esta utilizada pelo bolsista, conforme SM38
Diárias - SC/SP/SC SM 38	R$ 430,00	9/10/15	Participação em curso sobre espectrocopia de imepedancia, técnica esta utilizada pelo bolsista, conforme SM38
Diária - São Carlos/SP/ São Carlos (Leonardo Gallo)	R$ 139,00	3/12/15	Diária para doutorando Leonardo Gallo participar de entrevista nos estúdios do Programa Olhar Digital, conforme declaração anexa

Diárias Francisco Serbena de 01 a 05/02/16 - SC/Ponta Grossa/SC	R$ 960,00	1/2/16	O Prof. Franciso Serbena da Universidade Estadual de Ponta Grossa PR passou um tempo no LAMAV - UFSCar discutindo resultados e iniciando a redação de artigos em colaboração
Diárias Juliana Daguano 04/02/16 - SC/SP/SC	R$ 243,00	4/2/16	A Profa. Juliana Daguano da Universidade Federal do ABC - Campus São Bernardo-SP passou um tempo no LAMAV - UFSCar discutindo resultados e iniciando a redação de artigos em colaboração
Diárias Gisele Guimarães em 04/03/16 - SC/SP/SC	R$ 139,00	4/3/16	Diária para doutoranda Gisele Guimarães participar do Expo Revestir 2016
Diárias Congresso ICG 2016	R$ 1.994,70	10/3/16	Diárias para Prof. Edgar para participação do "24th International Congress on Glass" no período de 03 a 12/04/16 para apresentação de trabalho intitulado "Creation of a Glass Technician Training Course in Brazil" em Shanghai, China
Diárias - Congresso ICG 2016 em Shangai	R$ 5.460,15	19/4/16	Diárias para participação do 24 International Congress on Glass, realizado em Shangai, China
Diárias - Renato Siqueira Montreal/Canadá	R$ 2.833,84	19/4/16	Diárias para doutorando Renato Siqueira para participação do 10th World Biomaterials Congress, no período 17 a 22/05/2016 para apresentação de trabalho entitulado "Antibiofilm effect and stem cell viability of bioactive SiO2-CaO-P2O5 gel-glass withdifferent silica-content" em Montreal, QC Canadá
Diárias Leonardo Gallo - SC/Campinas/SC	R$ 160,00	30/4/16	Diária para doutorando Leonardo Gallo no dia 29/04/16 realizar discussões cientificas sobre análises de microscopia de transmissão, realizadas em amostras de material vitro erâmico, análises necessárias essas para escrita de artigo científico, no Laboratório Nacional de Nanotecnologia do Centro Nacional de Pesquisas e Energia e Materiais junto ao coordenador Jefferson Betti, em Campinas-SP
Diárias 03 a 06/05 - Reunião Magna da Academia Brasileira de Ciencias.	R$ 1.325,00	2/5/16	Participação em evento cientifico de importancia nacional cientifica e tecnologica. Sou membro afiliado da Academia Brasileira de Ciencias
Diárias - Daniel Cassar Madison/EUA	R$ 3.539,10	7/5/16	Diárias para o pós-doutorando Daniel Cassar para participação do Glass & Optical Materials Division Meeting 2016" no período de 18 a 28/05/16 , onde apresentou trabalho científico intitulado "Which equation best describes the euuitibriurn viscosity of glass-forming liquids?" , em Madison, WI USA.
Diárias 12 a 15/05 - Reunião Poços de Caldas/MG	R$ 1.080,00	9/5/16	Visita científica ao colaborador Gael Poirier que já foi devidamente justificada com certificado de estada - laboratorio localizado na Universidade de Alfenas, campus Poços de Caldas
Diárias 18 a 28/05/2016 - Madison/EUA	R$ 4.423,87	11/5/16	Diárias para participação do Glass & Optical Materials Division Meeting 2016" no período de 18 a 28/05/16 , onde apresentou trabalho científico intitulado "A random walk through Don Uhlmann's crystallization research" , em Madison, WI USA.
Diárias - Congresso Varna/Bulgária de 13 a 18/05/16	R$ 2.627,62	16/5/16	Diárias para participação de conferência em Varna/Bulgária, onde apresentei uma palestra como convidado
Diárias - Congresso Madison/EUA de 21 a 27/05/16	R$ 4.204,20	16/5/16	Diárias para participação de congresso em Madison, Wisconsin, onde apresentei uma palestra como convidado e recebi um prêmio da American Ceramic Society

Diárias 16/05/16 - 60º Congresso Brasileiro de Cêramica	R$ 270,00	20/5/16	Diárias para Prof. Edgar para participação do 60º Congresso Brasileiro de Cerâmica, onde apresentou plenária REFLEXÕES SOBRE 40 ANOS-DE PESQUISA, ENSINO, ADMINISTRAÇÃO E ATÉ UM POUCO DE ARTE EM MATERIAIS VíTREOS no período de 15 a 18/05/2016 em Águas de Lindóia-SP
Diárias Jefferson Tsuchida de 01 a 04/02/16 - SC/Lavras-MG/SC	R$ 640,00	1/2/16	O Prof. Jefferson Tsuchida da Universidade Federal de Lavras - MG passou um tempo no LAMAV - UFSCar discutindo resultados e iniciando a redação de artigos em colaboração

SERVIÇO DE TRANSPORTE

DESCRIÇÃO	VALOR	DATA DE EMISSÃO	JUSTIFICATIVA
Passagem aérea - SP/Detroit/SP	R$ 5.983,47	20/8/15	Participação em reunião técnica no período de 09 a 12/08/2015 na sede da Owens-Illinois, em Perrysburg, OH - USA
Passagem aérea para participação no 11th International Symposium on Crystallization in Glass and Liquid	R$ 4.681,23	2/9/15	Participação em congresso de interesse para as pesquisas desenvolvidas, com apresentaçãod e trabalho oral.
Passagens de ônibus - SC/SP/SC SM 38	R$ 117,90	20/10/15	Deslocamento para participação em curso sobre espectrocopia de imepedancia, técnica esta utilizada pelo bolsista, conforme SM38
Passagens de ônibus - SC/SP/SC SM 38	R$ 117,90	20/10/15	Deslocamento para participação em curso sobre espectrocopia de imepedancia, técnica esta utilizada pelo bolsista.
Passagens de trem	R$ 272,20	23/10/15	Deslocamento necessario para participação ao 11th International Symposium on Crystallization in Glass and Liquid.
Passagens de trem	R$ 448,90	5/11/15	Deslocamento necessario para participação ao 11th International Symposium on Crystallization in Glass and Liquid.
Passagens aéreas pesq. visitantes Guillermo Moraga e Eglantina Espinosa (Chile/SP/Chile - 24 e 29/08/15)	R$ 3.911,60	8/11/15	Passagens adquiridas para financiar a viagem dos pesquisadores Prof. Dr. Guillermo Gonzalez e a Profa. Dra. Eglantina Benavente do Grupo de "Química dos Compostos de Intercalação", Facultad de Ciencias, Universidad de Chile, realizada de 24 a 29 de agosto, 2015. Estes pesquisadores fazem parte da relação de colaboradores estrangeiros do projeto Centro de Pesquisa, Inovação e Difusão CeRTEV (Fapesp Proc. 2013/07793-6). Esta visita se insere dentro da colaboração científica entre nossos grupos, no qual participam também o Prof. Dr. Claudio J. Magon e a Profa. Andrea S.S. de Camargo, pesquisadores do CeRTEV. Nesta visita do Prof. Gonzalez e da Profa. Benavente discutimos os resultados dos estudos em andamento no IFSC utilizando a técnica de Ressonância Paramagnética Eletrônica
Pagamento de pedágio	R$ 73,50	25/11/15	Deslocamento necessário para aeroporto de SP - Participação ao 11th International Symposium on Crystallization in Glass and Liquid
Passagem aérea - Alemanha 24/06 a 25/07/16	R$ 6.156,86	29/1/16	Viajar para a Alemanha para realizar pesquisa de campo na Universidade de Münster
Passagem aérea - Alemanha 24/06 a 25/07/16	R$ 6.156,86	29/1/16	Este item esta devidamente justificado com cartas convites. Trata-se de estada cientifica no laboratorio do Dr. Christian Strassert na Universidade de Muenster, participação em congresso (convidada) em Trento Italia, visita cientifica ao laboratorio da Prof. Dra. Paola Ayala.
Passagens Aéreas Shangai	R$ 3.649,94	1/3/16	Passagem para participação do 24 International Congress on Glass, realizado em Shangai, China
Passagens Aéras Congresso Madison	R$ 3.492,75	7/3/16	Passagem aérea para participar do congresso sobre vidros - GOMD-nos Estados Unidos

Passagens aéreas RJ - Reunião Magna da Academia Brasileira de Ciencias.	R$ 1.224,00	29/4/16	Trata-se de evento cientifico. A justificativa já foi devidamente feita por certificado de apresentacao. Sou membro afiliado da Academia Brasileira de Ciências.
Passagens Aéreas - Madison/EUA	R$ 3.487,65	31/5/16	Transporte aéreo para participação do Glass & Optical Materials Division Meeting 2016" no período de 18 a 28/05/16 , onde apresentou trabalho científico intitulado "A random walk through Don Uhlmann's crystallization research" , em Madison, WI USA.

MATERIAL PERMANENTE

DESCRIÇÃO	VALOR	DATA DE EMISSÃO	JUSTIFICATIVA
1 computador completo	R$ 4.007,00	10/06/2015	Computador pessoal em substituição ao anterior que foi irremediavelmente danificado
TV Led	R$ 2.998,00	06/07/2015	Exibição de videos de divulgação científica nos eventos da SBPC, SNCT e Circo da Ciência
Projetor EPSON	R$ 2.972,05	14/07/2015	Para exibição de videos, seminários e aulas do CeRTEV
PC Aio, teclado, mouse, etc	R$ 5.448,34	28/07/2015	Foi adquirido um computador para tratamento de dados e para uso geral em minha sala na universidade. o antigo computar que havia sido comprado em 2009 com verba fapesp queimou e por esta razão outro foi adquirido
EA930 3K E220/S220	R$ 3.450,00	29/07/2015	No break para equipamento para Microscópio Confocal ZEISS
UPS PHD HVR	R$ 800,00	29/07/2015	Substituição de no break em equipamento FTIR Infravermelho Perkin Elmer Spectrum 1GX
Multifuncional	R$ 893,00	26/08/2015	Impressora para microcomputador de uso de pesquisador principal
Proc. Intel, MB Asus, etc	R$ 4.184,00	26/08/2015	Microcomputador de uso de pesquisador principal
3 livros	R$ 962,02	08/09/2015	Aquisição de 3 livros para a biblioteca do LaMaV entitulados: 1) Physical Chemistry of lonic Materiais: lons and Electrons in Solids, Maler, Joachim; 2) Glassy Materiais and Disordered Solids: An Introduction to T ir Statistical Mechanics (Revised Edition), Binder, Kurt e 3) Solid State Che istry and its Applications, West, Anthony R.
No Break Eaton 850VA 115V	R$ 600,00	24/09/2015	No break para computador
Osciloscópio	R$ 2.000,70	29/09/2015	Osciloscopio para equipamento Arotec Pulso ECO
3 livros	R$ 367,81	24/11/2015	Aquisição de 3 livros para a biblioteca do LaMaV entitulados: 1) lass: A world history, Mcfarlane, Alan 2) A history of the world in 6 glasses, Sandage, Tom, 3) Glass: A short history, Whitehouse, David
Vitrine box elegance	R$ 1.225,90	25/11/2015	Vitrine de vidro para exposição de galeria de vidros do LaMaV
Arquivo de aço cinza	R$ 1.020,00	15/12/2015	Armário arquivo de aço para armazenamento de documentos
1 computador	R$ 9.417,60	21/12/2015	Computador pessoal em substituição ao anterior que foi irremediavelmente danificado
Câmera CMOS	R$ 2.840,00	28/12/2015	Câmera CMOS será utilizada para a visualização e controle dos processo de fusão de vidros utilizando laser de CO2. Esta câmera será utilizada em conjunto com um microscópio óptico de foco contínuo par4a captura das imagens do processo
Multímetro digital de bancada	R$ 3.700,00	11/01/2016	Multímetro para medidas gerais em laboratório: voltagem, corrente, e principamente determinação precisa da temperatura de tratamento térmico em amostras vítreas.
2 Vitrines Elegance	R$ 2.350,80	01/02/2016	Vitrines de vidro para exposição de galeria de vidros do LaMaV
2 Vitrines Elegance	R$ 2.350,80	01/02/2016	Vitrines de vidro para exposição de galeria de vidros do LaMaV

Monitor LG 23 led	R$ 735,00	04/02/2016	O teclado de um dos equipamentos do laboratorio quebrou e necessitou ser substituido. Baterias são materiais de consumo
Estabilizador de Tensão AC 3.00K VA - Bifásico	R$ 3.740,00	18/02/2016	Estabilizador de tensão para proteção elétrica de equipamento DSC F1 Netzsch no Departamento de Engenharia de Materiais da EESC/USP, de uso extensivo para análises em materiais vítreos no âmbito do CeRTEV.
Transpalete 530mm TM2220 nylon simples	R$ 1.280,88	01/03/2016	Tubos de plástico para o ângulo mágico girando fornecimento de ar no laboratório RMN
monitor LG 23 led	R$ 763,00	01/03/2016	Monitor para computador do LaMaV
Base boarduino, Nanoshield ADC, etc.	R$ 260,00	03/03/2016	Micro-processador do tipo Arduino, com periféricos para termopar, digitalização de sinais e interface para disco SD a ser utilizado no controle de um forno elétrico
Câmera IR Dome 3,6mm	R$ 260,00	07/03/2016	Câmeras de segurança para o Laboratório
Microcomputador intel core I7	R$ 4.840,00	16/05/2016	Este computador está sendo utilizado por este pesquisador no laboratório de Ressonância Magnética do IFSC/USP nos estudos atrelados ao Centro de Pesquisa, Inovação e Difusão CeRTEV (Fapesp Proc. 2013/07793-6). O computador contém um processador CPU Intel Core 4.4 GHz, um disco rígido 1TB, 8GB de memória, gabinete, teclado e um monitor de 23 polegadas. Este computador é adequado para processar os resultados dos estudos de espectroscopia de Ressonância Paramagnética Eletrônica (RPE) e a elaboração de artigos e relatórios

Seguro saúde	R$ 330,00	25/2/16	Seguro saúde para prof. Edgar para participação do “24th International Congress on Glass” no período de 03 a 12/04/16 para apresentação de trabalho intitulado “Creation of a Glass Technician Training Course in Brazil” em Shanghai, China
Seguro Saúde Russia	R$ 186,00	16/3/16	Participação no 20th Research Workshop Nucleation Theory and Applications, de 14/04/2016 à 25/04/2016, em DUBNA, RÚSSIA, com apresentação oral do trabalho "The Effect of Particle Morphology on the Sintering of a Diopside Glass"
Taxa de inscrição - ICG 2016 Shangai/China	R$ 2.664,59	7/4/16	Serviço de pagamento de taxa de inscrição para Prof. Edgar para participação do “24th International Congress on Glass” no período de 03 a 12/04/16 para apresentação de trabalho intitulado “Creation of a Glass Technician Training Course in Brazil” em Shanghai, China
Inscrição Congresso Montreal/Canadá de 12 a 17/06/16	R$ 1.778,33	11/5/16	Participação do 17th lnternational Conterence on Optical, Optoelectronic and Photonic Materials and Applications", no período de 12 a 17/06/2016, com apresentação de trabalhos entitulados "Optical, Structural and Maegnetical Studies of Mn2+ Doped SbPO4-ZnO-PbO Glasses" (oral) e "A new SERS substrate based on niobium lead-pyrophosphate glasses obtained by Ag+/Na+ ion exchange" (poster) em Montreal, Canadá
Inscrição Congresso ICTON de 11 a 14/07/2016	R$ 2.314,78	16/5/16	Inscricaco para participaco no referido evento a ser realizado em tRento - Italia 10-14/07/2016 para o qual sou uma das palestrante convidada. Já devidamente justificado com carta convite.
Inscrição 60º Congresso Brasileiro de Cêramica	R$ 798,00	16/5/16	Participação no 60º Congresso Brasileiro de Cerâmica, em Águas de Lindóia, SP, realizado de 15 a 18/05/2016, nos dias 16 e 18/05/2016 (com intervalo de um dia entre os dois afastamentos), onde apresentou o trabalho "DESENVOLVIMENTO DE UM EQUIPAMENTO LABORATORIAL DE TAPE CASTING PARA COMPONENTES MULTICAMADAS"
Inscrição Congresso Madison/EUA de 22 a 26/05/2016	R$ 2.852,33	31/5/16	Para participar da conferência há a necessidade de se pagar a taxa de inscrição na mesma
		DIÁRIAS	
DESCRIÇÃO	**VALOR**	**DATA DE EMISSÃO**	**JUSTIFICATIVA**
Diárias Paris/França	R$ 8.517,12	25/8/15	Participação com apresentação de trabalho na 17th International Conferenceon II-VI Compounds and Related Materials
Diárias SBPMat (27/09 a 01/10)	R$ 1.896,00	15/9/15	Para participacao da SBPMat já devidamente justificado com cartas convites, certificado de participacao, apresentacao trabalho, etc.
Diárias - São Carlos/Bangkok/São Carlos	R$ 3.869,10	15/9/15	Diárias internacionais (Bangkok)para participação no Annual Meeting, International Commision on Glass, 20-23 setembro 2015, com apresentação de trabalho oral.
Diárias para participação no evento 11th International Symposium on Crystallization in Glasses and Liquids	R$ 5.000,38	2/10/15	Participação em congresso de interesse para as pesquisas desenvolvidas, com apresentaçãod e trabalho oral.
Diárias - SC/Charles de Gaulle/Paris/SC	R$ 2.888,33	19/10/15	Participação convidada na Mesa Redonda "Prospects for International Scientific and Technical Cooperation -21st Century Challenge" e apresentação oral convidada "Bio glass and glass-ceramics for medical applications" no Interdisciplinary Youth Scientific Forum «New materials. Science days. Saint-Petersburg 2015», de 20 a 22/10/2015, além da apresentação oral convidada "Innovation at University of Sao Paulo and the Center for Research, Technology and Education in Vitreous Materials, Brazil" em sessão plenária do Forum "Innovation and technological cooperation in the field of chemistry for the development of the North-West region of Russia", 22 a 23/10/2015, no Institute of Silicate Chemistry da Russian Academy of Science, em St. Petersburg, Russia.
Diárias Araraquara/RJ/Araraquara	R$ 1.896,00	27/10/15	Diárias para Congresso Rio de Janeiro 27/09 a 01/10 XIV Brazil MRS Meeting
Diárias Chile de 10 a 17/01/16	R$ 7.042,70	8/1/16	Diárias para o prof. Edgar realizar visita técnica no período de 10 a 17/01/2016 ao Departamento de Física da Universidade do Chile, e discutir projetos de pesquisa e conjunto com o Prof. Fernando Lund e apresentação de aulas
Diárias - Shangai - 06 a 11 abril/2016	R$ 2.684,47	4/4/16	Diarias para participação no Congresso Internacional de reunião de vidro, onde apresentei uma palestra como convidado
Diárias 14 a 25/04/16 - Russia	R$ 4.614,38	30/4/16	Participação no 20th Research Workshop Nucleation Theory and Applications, de 14/04/2016 à 25/04/2016, em DUBNA, RÚSSIA, com apresentação oral do trabalho "The Effect of Particle Morphology on the Sintering of a Diopside Glass"
Diária 18/05/16 - Águas de Lindóia	R$ 270,00	18/5/16	Participação no 60º Congresso Brasileiro de Cerâmica, em Águas de Lindóia, SP, realizado de 15 a 18/05/2016, nos dias 16 e 18/05/2016 (com intervalo de um dia entre os dois afastamentos), onde apresentou o trabalho "DESENVOLVIMENTO DE UM EQUIPAMENTO LABORATORIAL DE TAPE CASTING PARA COMPONENTES MULTICAMADAS"
Diária 20/05/16 - Águas de Lindóia	R$ 270,00	20/5/16	Participação no 60º Congresso Brasileiro de Cerâmica, em Águas de Lindóia, SP, realizado de 15 a 18/05/2016, nos dias 16 e 18/05/2016 (com intervalo de um dia entre os dois afastamentos), onde apresentou o trabalho "DESENVOLVIMENTO DE UM EQUIPAMENTO LABORATORIAL DE TAPE CASTING PARA COMPONENTES MULTICAMADAS"
Diárias Madison/EUA	R$ 8.469,36	31/5/16	Necessidade de se hospedar/alimentar e se locomover na cidade onde ocorreu o congresso