

To whom it may concern

**Evaluation of the report of the CeRTEV - Center for Research, Technology and Education in Vitreous Materials
Reporting period 07/2020-06/2021**

As a member of the International advisory board of the CeRTEV, I was contacted by prof. Edgar D. Zanotto, the Centre's director with the request to evaluate the report on research, educational, outreach, and innovation activities of the Centre. Based on the information provided I came to the following conclusions:

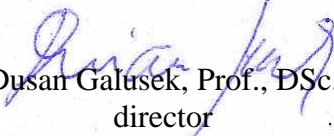
1. The Centre continued in their efforts from previous years, successfully applying innovative approaches in design of glasses with tailored properties, and their prediction. These include the use of algorithms for database mining, training, and testing composition-property models with the use of machine learning, as well as the application of theoretical approaches based on MD a DFT for predicting structure and properties of glass. The research of the Centre strived for understanding of fundamental questions related to glass forming ability, crystallinity control in glass ceramics, and achievement of desired properties of glass, with special focus on mechanical, electric, and biological properties. In the reporting period, the scientific results of the Centre were published in 81 peer-reviewed papers.
2. In the educational and outreach activities the Centre continued its education of glass specialist in the frame of the course "Technician in Glass Production", with around 40 enrolled students, out of whom 27 graduated within the reporting period. 40 new students were enrolled in 2021. Due to the pandemic situation, the face-to face scientific workshops had to be suspended and were replaced by online meetings. The Centre organized a number of various events generating awareness on glass among general public, focusing also on young generation, people with disabilities as well as gender issues in science. The links to these activities are provided in the report.
3. In the field of Innovation and technology transfer, the Centre was successful in securing contractual research for leading world glass companies, including AGC, Ivoclar, Nippon Electric Glass, and Schott, with the total sum exceeding 600 k€. The CeRTEV spin-off company VETRA Biomaterials participated in the CERTEV outreach activities, and collaborated in pre-clinical and clinical research with several universities in Brasil. The research collaboration between CERTEV and VETRA resulted during the reporting period in publishing 8 peer reviewed research papers. Three national patent applications have been filed. The Centre also participated on development of a range of scientific instruments to increase the portfolio of its research facilities.
4. A number of research initiatives were under way in CeRTEV during the reporting period, focused on combating Covid 19 pandemic, running 6 research projects related to monitoring the viruses and Covid 19 patients.
5. The Centre grows in worldwide recognition, as demonstrated by high citation response to its scientific work. More importantly, this recognition is not restricted to limited number of excellent individuals, but it is applicable to the Centre as a whole.

Summary:

CeRTEV is a research Centre of international significance and recognition. Apart from purely scientific activities, the Centre extensively participates in education of scientists and technicians, with

special focus on the youngest generation. Its publicity and outreach activities are outstanding. The Centre obtains a significant amount of its funding from industrial collaboration, demonstrating high application potential of its research activities.

Trenčín, July 14, 2021



Dusan Galusek, Prof., DSc.
director

Assessment report for CeRTEV activities in 2020 - 2021

July 16th, 2021

Tokyo University of Science
(Partnership laboratory with AGC Inc.)
Professor Kei Maeda

CeRTEV continues great scientific research activities despite difficult time due to COVID-19 pandemic. Those are evident from 55 excellent papers. They are continuously focusing on glass property prediction and crystallization of glass (glass-ceramics), which are essentially important for both glass science community and glass industry people. The glass property prediction using machine learning techniques now makes it possible to design ultra-high performance glass products. Research fruits by CeRTEV can be widely applied for this purpose. Also, recently the demand of high-performance glass-ceramics are increasing, especially in the field of life science and cover glass for electric device such as smartphones. CeRTEV's research gives a good guideline to people who want to design glass-ceramics with superior properties. One of the good achievements appears on the paper entitled "Highly translucent nanostructured glass-ceramics" (ref. 18), where they demonstrated a new glass-ceramics based on $\text{Li}_2\text{O-SiO}_2$ system with high transparency and high strength. Not only that, their wide range scope on glass science and technology is valuable for all researchers and engineers in glass community all over the world.

The year 2022 is decided to be "International Year of Glass" by United Nations. I hope CeRTEV continues their excellent works and contribute to this memorial year.

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Dear Edgar and Hellmut,

Thanks for sharing the 2020-21 Annual Report of CeRTEV, which I have read with much interest. My overall impression of fundamental science, application driven developments, technology transfer and innovative education contributions is that they are uniformly of very high quality with some contributions simply outstanding. We have been hearing terrible stories and dire situations from the pandemic in Brazil. It is simply remarkable to see how CeRTEV adapted to new limitations and continued to make progress despite this historic adversity. Congratulations to you and your team for the various accomplishments!

Whereas the general quality of research is high, I found a couple of developments particularly remarkable with regard to their potential for making an impact on the field of glass science. I believe that the use of machine learning approaches for designing glass compositions yielding optimum combinations of diverse properties will be very valuable, and I am happy to see a couple of publications reporting progress - excellent first step! I believe that much greater achievement will be made when such approaches are combined with fundamental scientific understanding. Then both consistencies and inconsistencies between the two approaches would need to be analyzed and used to improve both approaches.

Ultimately, the impact of a center like CeRTEV is in demonstrating how it has affected society in a positive way, besides scientific research and education. The contributions of bioactive glass research clearly fall in this category, which are quite significant. It is further impressive to see that CeRTEV has responded to the pandemic by deciding to do something about it. I realize that antiviral research is an order of magnitude more complex and difficult than antibacterial studies. Is CeRTEV planning to pursue it for the long term and sufficient depth?

Due to my personal interest, I found the publications on the effect of relaxation on nucleation very interesting. Hopefully, it could be the answer to the orders of magnitude discrepancies between experimental and theoretical values of nucleation rates. To establish this explanation unequivocally one would need to measure them dynamically under the same conditions. Essentially, I am suggesting developing in situ characterization methods. Some progress has already been reported with in situ Raman spectroscopy, and it will be important to further build this approach with complementary techniques. I realize that it is easier said than done, especially at the nucleation stage, but CeRTEV may have the right expertise to pursue this direction.

I continue to remain in awe with the educational impact that CeRTEV has been making toward the training of technicians for the Brazillian glass industry, and educating the public about glass. Is there an evaluation of the impact of these activities? In any case, keep up this excellent work!

Kind regards,

Himanshu

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The São Paulo State Research Foundation

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Erlangen, 19.07.2021

CeRTEV - Center for Research, Technology and Education in Vitreous Materials Report July 2020 – June 2021

Dear Sirs,

This letter is to provide feedback on the annual report (July 2020 – June 2021) of CeRTEV - Center for Research, Technology and Education in Vitreous Materials. The report confirms the important progress in the activities of the Centre, with focus on both fundamental research on glasses and glass-ceramics, and in application areas. It is always important for us at Institute of Biomaterials, University of Erlangen-Nuremberg, to monitor the progress in the field of bioactive glasses around the world, as this field is at the center of our research activities, and certainly we follow with high interest continuously the developments and innovations coming from CeRTEV.

CeRTEV has developed two bioactive compositions namely biosilicate (BS) and F18, which are continuously investigated in terms of applications in dental restoration, osteo-stimulation, and tissue engineering. I am especially impressed by the high number of publications in medical journals showing the application of the materials in the orthopedic sector and as antibacterial materials. The application of photobiomodulation treatment introduced by CeRTEV researchers in collaboration with Federal University of São Paulo is an important advance showing its effective application in modulating inflammatory processes after an injury, and accelerating soft and hard tissue healing.

The bioactive glasses developed at CeRTEV are also being tested for their bactericidal and anti-biofilm activity, e.g. against methicillin-resistant *Staphylococcus aureus* (MRSA) biofilms. Another important development in the field of bioactive glasses, is the study of novel compositions of boron-containing systems, for example incorporating Ti and phosphorous. Borosilicate glasses exhibit angiogenic effects and are highly relevant for both hard and soft tissue engineering. Thus the fundamental work of CeRTEV researchers on such glasses is very relevant in the field and it has the potential to contribute to the establishment of quantitative

structure-property relationships for the design of borosilicate glass compositions with tailored ionic release behavior.

In the context of my participation as international partner in the FunGlass International Centre in Trencin, Slovakia (<https://www.funglass.eu/>), and the recommended links between CeRTEV and FunGlass Centre, it is important to highlight that Prof. Zanotto has become a member of the scientific council of FunGlass and in this way closer collaboration between the two centers should be expected.

Regarding the numerous activities that the members of the Centre have carried out in the last year, beyond scientific research and excellent publications record, I would like to highlight the several education and outreach activities directed to the general community. Here several communication platforms have been used, in particular Radio UFSCar, and a wide range of educational activities in the framework of the EduSCar initiative have been performed. I have also noticed a new CeRTEV webpage.

It is important to highlight also the establishment of new cooperation agreements with industry and the good number of patent applications filed with the Brazilian National Institute of Industrial Property.

As last year, it is also important to highlight the contributions of CeRTEV's experts to tackle the COVID-19 pandemic challenges. In this regard, stronger collaboration with laboratories across the world engaged in similar research should be enhanced as the pandemic emergency continues.

Once again, I congratulate Prof Edgar Zanotto, CeRTEV director, and all CeRTEV members for the very high number of high quality outputs achieved during the last year, that continue to elevate CeRTEV as an international leading Centre for glass research and education.

I wish the Centre much success in the future activities.

Sincerely yours,



Prof. Dr.-Ing. habil. Aldo R. Boccaccini



15/07/2021

Comments on the report:

CeRTEV - Center for Research, Technology and Education in Vitreous Materials

Report July 2010 – June 2021

It's a pleasure to comment on the report of the "Center for Research, Technology and Education in Vitreous Materials".

Within the reported period of time, the Center for Research, Technology and Education in Vitreous Materials" was again doing very well. They performed fine studies dedicated to numerous fields of glass science and glass technology. Among the most challenging topics, studies on ionic conductors and on biomaterials are to be mentioned. It should be noted that ionic conductors based on glass are nowadays not only of great scientific interest, but also possess a high economic potential, due to their utilization in lithium batteries and hence in electromobility. Biomaterials are also of increasing importance due to increasingly aging societies. Here, their use as material for bone replacement as well as in various fields in which a specific interaction of an inorganic material with a biological environment is desired, is decisive. Amongst the special advanced techniques performed in the Center spectroscopy, and especially solid state NMR techniques are to be mentioned which enable an accurate determination of the glass structures and their dependency upon the chemical composition. This in turn allows to establish structure/properties relations and hence a more accurate tailoring of glass and glass ceramic properties. One of the specialties of the Center is to perform fundamental studies on glass crystallization. Here especially theories on glass nucleation and crystallization as well as their connection to molecular dynamics is to be mentioned. This enables and facilitates the search for special compositions, which is the central question of glass and glass ceramic chemistry.

The broad expertise and the very different backgrounds of the respective principal investigators results in a large synergetic potential which also enables the covering of very different fields of applications.

The number of the original publications and the quality of the journals they are published is very impressive as well as the number of talks given in national and international meetings. Additionally, an increasing number of review papers were published. This all is complemented by teaching activities as well as various other activities such as pod casts, glass comics and music and theater events. Very surprising and impressive for me is the large variety of activities dedicated to coronavirus pandemic performed in the past 15 months. This could only be achieved by the synergies of a center with hypercritical size and a well-organized cooperation of various fields within the Center.

In summary, the Center is an increasingly great success and amongst the leading glass research institutions worldwide.

Christian Rüssel



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Report on the activity of CERTEV from July 2020 to June 2021

The present report confirms that CERTEV is a center of excellence recognized worldwide for its outstanding research in glass science. Scientists at CERTEV develop a continuum of activities from cutting-edge fundamental research to application-oriented studies. Fundamental research deals with the thermodynamic and kinetics of glass formation, relaxation, and crystallization towards glass-ceramics, in a general context of understanding and predicting glass-forming ability. A large effort has been devoted to data mining and machine learning techniques, which is quite new in the field. Application-oriented studies are focused to four principal high-end technological areas: (1) structural reinforcement materials for architecture and construction, glasses with higher scratch- and impact resistance for TV and smartphone displays, for armor (bullet-proof windows), as well as for dental restoration, (2) bioactive glasses and glass-ceramics for implants and to serve as scaffolds stimulating bone growth and tissue healing, (3) fast glass-ceramic ion-conductive materials enabling the design of lithium and sodium ion batteries with higher capacities and higher power-densities as required for electromotion, and (4) photonic glasses and glass-ceramics.

It should be noted that scientists and groups at CERTEV work together to carry out their research projects. In addition, they are involved in a large Brazilian and international collaboration network.

The scientific production is still very high (more than 70 articles in 2020-2021, in significant increase as compared to the production reported in the previous 12-month period), most of them being published in very good journals dedicated to glass or material sciences. A good indicator of the original character of the work is the number of patents obtained by CERTEV every year, especially in the field of bioglasses (3 patents in 2020).

Numerous research project were granted to CERTEV, including projects with national and international companies. The projects obtained with prestigious companies like Nippon Electric Glass in Japan and Schott Glass in Germany must be outlined.

The international recognition is well accounted for by the significant number of oral presentations, and especially invited lectures (9 in 2020-21) that could be delivered on-line because of the sanitary situation. Several other talks were cancelled unfortunately, due to COVID-19. Several scientists are members of international editorial boards. The director of CERTEV is the editor of the Journal of Non-Crystalline Solids, which is the journal of reference for the international glass community.

The attractivity of CERTEV is excellent, as shown by the large number of post-docs involved in research projects (26 in 2020, 22 in 2019, in significant increase as compared to the 2017-2018 period). CERTEV is also extremely effective in the education of new doctors in material science with as much as 20 PhD thesis, either defended or in progress in 2020.

Also, CERTEV develops an impressive strategy in promoting science among the society, especially with the development of professional qualifications in glass science and technology, and with the diffusion of basics of glass science into the public, including young people. Thus, the number of glass technicians, necessary to the Brazilian industry, educated and trained at CERTEV is very high (27 in 2020 despite the sanitary crisis, 32 in 2019), as compared to the situation in other countries. 70 % of them were employed in their technical domain. Among the numerous and remarkable actions dedicated to the public, one can cite the very original use of pod-casts on the radio.

In conclusion, CERTEV is among the very few glass research and education centers that are well-identified and recognized at the international level, thanks to its excellent research and promotion of science.

Rennes, July 16th, 2021



Dr. Jean-Luc Adam, CNRS Research Director



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Evaluation of activity of CeRTEV in the period July 2020 – June 2021

My assessment of the activities of CeRTEV with respect to research, education & outreach and technology transfer is based on the CeRTEV report that has been distributed to the international board members, as meetings with the PIs could not be held due COVID-19 pandemic situation in this period.

Research

PIs of CeRTEV have continued in carrying out cutting-edge research in the fields of strong, bioactive, fast ion-conductive and photonic glasses and glass-ceramics as well as on issues of their fundamental understanding. As has already been true of the last review periods, the current number of research publications (55) in peer-reviewed journals remains in the top-level. Among these, a solid fraction of joint papers of CeRTEV's PIs (12 with 2 PIs and 3 with 3 PIs) is present, which reflects the constant cooperation between the different groups. Further, the continuous large share of co-authors from abroad highlights the strong international visibility as well as the high-level of networking, cooperation and commitment of each PI in cooperation with groups outside Brazil (21 papers =38% are co-authored with international scientists).

Education and Outreach

The numerous activities show that despite the pandemic motivated restrictions CeRTEV was able and highly successful in developing online-tools to diffuse their knowledge of glass science to professionals and students as well as to a public without any specific background. Number and efficiency of the different digital formats (contests, theatre, circus of science, comic books, etc.) are truly remarkable and differ considerably from the low level of activity of other collaborative research centres in Germany, which I had to evaluate for the period of the pandemic situation. Besides science, a central element in this regard is that CeRTEV was very active and successful to pass on media competence through the education system, which will help to overcoming the digital divide in terms of people's media skills in an international comparison.

Innovation and Technology Transfer

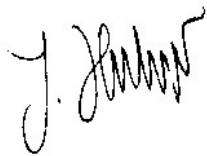
PIs of CeRTEV also stood out in their activities to expand and consolidate cooperative ventures with Brazilian (CBMM, Alacer Biomédica, Bramagran, Cajugram, Magban) and international companies in Japan (Asahi Glass Company, Nippon Electric Glass), Liechtenstein (Ivoclar Vivadent) and Germany (Schott). I would highlight as particularly important that CeRTEV's approach: "bringing science to business" especially applies to the spin-off company VETRA Biomaterials, which moved to Ribeirão Preto for opening production lines under private investment from Jacto Group, supplying contracts with two other national companies and developing new technologies for dentistry and medical use.

Lastly, the company VETRA Biomaterials a good example: I wish that also the achievements in other fields of excellence such as fast-ion conductive glasses and photonic glasses would take the route of a spin-off company of CeRTEV. This might become an essential mission of the remaining project duration.

To summarize my assessment, I consider the achievements of CeRTEV in all three domains to be very important. They are continuously outstanding and I would like congratulate the PIs for the hard work to keep this very high level of excellence in 2020/21.

Clausthal-Zellerfeld, Germany

July 19, 2021

A handwritten signature in black ink, appearing to read 'J. Deubener', written in a cursive style.

Prof. Dr. Joachim Deubener

Aalborg, July 19, 2021

Assessment on CeRTEV in July 2020 to June 2021

In the past year, CeRTEV has again made amazing progress in both fundamental and applied research in the field of glass materials, as well as in technology transfer and education. The activities of the center cover a broad range of original research topics such as high mechanical performance glasses, bioactive glasses and glass-ceramics, fast ion-conductive glass-ceramics and photonic glasses and glass-ceramics. Their research outcomes have been reflected in over 100 peer-referred journal articles and 3 patent applications (see their report). This is particularly impressive considering the challenging pandemic time. Their advances thank to the outstanding management of the center leaders and principal investigators, and their team workers. In addition, the success of CeRTEV is also strongly associated with its strong international collaboration network. The center has excellent reputation to attract the international collaborators and young scientists. It is worth mentioning that the paper “Understanding glass by DSC” (Chem Rev 2019, IF=60.6), which was written by an international team including Zanotto, Montazerian, me and other collaborators, has been cited 74 times just after less than 2 years.

CeRTEV has made great progress in transforming their scientific findings and results into industrial technology and innovation. This is an important mission for such an internationally recognized research center.

CeRTEV has made considerable contributions to education of young researchers and students by initiating and organizing various activities despite the pandemic time.

Based on their outstanding research environments, CeRTEV has a great potential to be further developed and to deliver highly original results to scientific communities and society. I wish the center to continue their effort in fundamental and applied research and publish high impact articles in future. I am confident that CeRTEV will continue to be a successful leading research center in the field of glass science, technology and education.



Yuanzheng Yue

Professor of Chemistry
Fellow of the European Academic of Sciences

Report on CERTEV activities (2020-2021)

By

Dr Annie Pradel

Senior Researcher at CNRS

Université de Montpellier (France)

The **Center of Research, Technology, and Education in Vitreous Materials (CeRTEV)** is a joint effort of the Federal University at São Carlos (UFSCar), the University of São Paulo (USP) and the State University of São Paulo (UNESP), to conduct research in the area of Functional Glasses and Glass-Ceramics. It started in 2013 with the claimed goal to develop activities in three main directions: Research, Technology, Educational and Outreach Activities in an equilibrated and harmonious way. After four years of successful running, it was renewed in 2018 for 6 more years. Three years after its renewal, in 2021, its production continues to be outstanding as shown below.

In the field of fundamental and academic research, while the effort focused on tackling questions dealing with the thermodynamic and kinetic foundations of glass formation, relaxation, and crystallization towards glass-ceramics are ongoing, the main innovation comes from the will to move forward from (educated) trial-and-error to data- and simulation-driven strategies to design glass compositions with desired combinations of properties. A computer program was developed that led to excellent results, an important stepping stone in the pathway of machine learning-guided design of novel glasses. Application-oriented research aims to develop new and improved glasses and glass-ceramics for four principal high-end technology application areas: (1) structural reinforcement materials for architecture and construction, TV and smartphone displays, armor, as well as dental restoration, (2) bioactive glasses and glass-ceramics for bone healing and growth, (3) fast glass-ceramic ion-conductive materials enabling the design of innovative lithium and sodium ion batteries (4) photonic glasses and glass ceramics. The research carried out at CeRTEV in these fields is extremely active as attested by the large production of papers (109 in the period covered by the report). The excellent work is internationally recognized as acknowledged by numerous invited (13) and plenary (5) talks at the main national and international 2020-2021 conferences in the field. Such strong activities strongly benefit to the formation of young researchers since 77 of them worked in the CERTEV laboratories last year with 7 being graduated in this period.

Efforts to extend the fundamental and academic research towards **industry and technological transfer** has been successful in the last period with many projects for technology development going on between CeRTEV members and Brazilian (Alacer Biomédica) and international (AGC, NEG, Ivoclar, Schott) companies. A project with CBMM (Brazil) that was still under discussions last year is now funded. Several other projects are currently under discussions (CEBRACE, BRAMAGRAN, CAJUGRAM and MAGBAN (Brazil). These efforts also resulted in three patent applications with the Brazilian National Institute of Industrial Property (BR 10 2020 023996-1, BR 10 2020 017697-8, BR 10 2021 007715-8), about twenty glass-technology related articles and development of instrumentation devices such a EDOS-HiV viscosimeter for high viscosities, up to $10^{16.5}$ Pa.s. The spin-off company VETRA, the most important success in terms of technological transfer, is developing and registering great successes, with, for example, two FAPESP projects (PIPE 2019/09099-6 and 2020/09584-9) and

a FINEP challenge (*Mulheres Inovadoras*) currently running and a private investment from Jacto, an important Brazilian group, recently obtained.

The domain of Educational and Outreach Activities has been particularly affected by the Covid-19 crisis since face-to-face events had to be canceled. A huge effort has been done to adapt most of them as on-line events and create new events to specifically meet this demand. Many online courses, videos can be found on youtube or facebook. Several online meetings and workshops were organized. Other activities that did not required face-to-face meetings were maintained and developed such The Vitreous Minute podcast series at Radio UFSCar and the production of comic books and science comics. On the whole, despite the pandemic, it was possible to maintain strong educational and outreach activities during the last year. This situation had also an unexpected advantage. Indeed, while interaction is certainly most effective in the face-to-face mode, the production of new contents and their on-line availability allow to expand the dissemination of projects and so, it was concluded that this new communication way should be more strongly incorporated into CeRTEV's future educational outreach efforts.

In conclusion, in the last year, despite the pandemic situation, CeRTEV members have been very productive in the field of functional glasses and glass-ceramics, whatever the considered activity domain - Research, Technology, Educational and Outreach Activities.

The production is large and varied: publications in international journals, invited communications in international conferences, patent applications, contract agreements with national and international companies, continuing development of a spin-off company, educational activity towards young public. The past year again, through their production, the CeRTEV members confirmed that they deserved the trust they have been given by renewing the Center funding in 2018.

CeRTEV activities 2020-2021

CeRTEV is to be congratulated on maintaining its excellent publication record with 60 articles covering a wide range of glass and glass-ceramic science topics. The group continues to contribute significant fundamental understanding of the nucleation process in glassy materials; extending the latter to non-stoichiometric systems is a welcome but challenging direction. However, regarding the structural relaxation simulations, it is recommended, despite the computational complexity, that future work focus on compositions that are at least glass-forming on a lab scale. The experimental work that resulted in the development of a Li metasilicate glass-ceramic with very good mechanical properties is intriguing, particularly if the chemical durability can be improved without compromising the excellent fracture toughness. If this material is truly sufficiently distinct from previous formulations in this well studied system, it should be considered for patent protection. With the ion-conducting glass-ceramic work turning towards Na from Li, this may result in materials with improved glass stability and, hence, more robust glass-ceramics. It is recommended that some thought be given towards devising a means of processing these glass-ceramic materials into thin sheet, as this is the desired format for most solid-state electrolytes. The studies of optical materials containing nanoparticles are novel and interesting, but it would be good to be sure that these nanoparticles are truly uniformly dispersed, particularly in the CoPt case.

One of the major successes of the CeRTEV project has been its work in the area of education and outreach. The technician in glass production seems to have been – and continues to be – very worthwhile, with many graduates finding employment in the Brazilian glass industry. The vitreous minute podcasts are another bright spot – I have listened to a number of these and it would be interesting to conduct a survey to see how these have affected the general public's understanding and appreciation of glass.

Finally, it is impressive to see the hands-on skill of certain CeRTEV researchers, particularly Oscar Peitl, in the in-house fabrication of sophisticated experimental equipment including viscometers and mechanical testing devices.

All in all, another very good year of research progress.

Bruce G Aitken

Review - CeRTEV activities: 2020 – 2021

The report on CeRTEV's activities in 2020-2021 again proves the high scientific efficiency of this interdisciplinary cooperation. Furthermore, also considering the previous evaluation periods it demonstrates a high level of continuous progress at every level: science, internal organization, external and international collaborations.

CeRTEV comprehensively covers all important fields of glass and glass-ceramic research and therefore brings along the best requirements to stimulate cutting edge research. The core areas defined in the beginning of CeRTEV's research activities are still up to date and reflect prominent fields of interest in science, technology as well as society. Important to mention here are the efforts in the research on simulation, machine learning and digitalization in general. Not to forget the flexibility of CeRTEV proven by the fast and specific consideration of research topics related to the Covid-19 pandemic.

Once again positively highlighted should be the efforts of the CeRTEV put into the education of young academics and professionals as well as its efforts enhancing the popularity of science in general.

Dr. Markus Rampf

Ivoclar Vivadent AG

Head of Department / Technology Inorganic Chemistry

Report on the activity of CERTEV 2020-21

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Under the world has faced a difficult situation by COVID, CERTEV has kept being active to glass science and education. Their dedicated fields in glass science are "Glass property predictions", "Relaxation, Nucleation and Crystallization", "Strong glasses and glass-ceramics", "Bioactive Glasses", "Fast solid electrolyte glasses and glass-ceramics", and "Photonic glasses and glass-ceramics". They released many original research articles to leading journals in inorganic, physics, and chemistry, at least 3 articles for prediction, 13 articles for crystallization, 4 articles for electrolyte, 4 articles for strong glasses, 17 articles for bio, and 14 articles for optics which exert influence a research institute worldwide. Furthermore, the research achievements are not only to academic journals but also to patents (3 patents applications) that have high potential to be able to apply for industries in the future. In the efforts, immediate movings into action to COVID, activities for the developments of sensor and biomaterial, should be deserved.

From my industry point of view, glass property prediction is impressive in which the researches have been done not only by experiment but also by a combination of data science and computational science with powerful theory. As conjugation of data science and computational science start to be extremely active in any science field all over the world, I believe CERTEV will establish a new way of prediction in glass science dealing with the thermodynamic and kinetic foundations of glass formation, relaxation, and crystallization. Another impressive point is that the works have been conducted by many international collaborations. To become a hub in glass science will be able to gather cutting-edge information and talented scientists into Brazil leading to give them a positive spiral for their research.

Regarding education and outreach, even in the COVID situation, CERTEV also develops a way for access of glass science to much broader people beyond specialists, especially to young prominent students and scientists using IT, radio, and Manga.

In conclusion, CERTEV is a world-leading center of glass science in advanced research and education that is recognized internationally in this period 2020-21.

Otsu Shiga JAPAN, July 29th, 2021

中根 慎護

Dr. Shingo Nakane,
General Manager in Nippon Electric Glass Co; Ltd.



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July 28, 2021

Dr. Edgar Zanotto
Director, CeRTEV
Brazil

Subject: My observations on the activities of CeRTEV July 2020-June 2021

Dear Edgar:

I am pleased to attach my feedback on your activities during the past year. The feedback is classified into “Areas of Strength” and “Areas for potential growth”. Your center involves the two São Paulo state universities (USP and UNESP) and the Federal University of São Carlos with participation from 14 faculty (10 PI’s and 4 collaborators), 60 students and post-doctoral students.

To summarize, the year 2020 through now has been a disaster for the world since the Great Depression due to the Covid-19 infection. I am in fact amazed that, despite the threat of infections, CeRTEV managed to have made significant amount of progress. Any achievement in the past year is a brave effort on your Center’s part.

Areas of Strength

- (1) *Excellent research programs.* Your concentrations are in the areas of (a) knowledge-driven (b) application-driven topics. In knowledge-driven topics, you focus on understanding and predicting glass-forming ability, relaxation, nucleation and crystallization, estimating physical properties of traditional glass and glass-ceramics with emphasis on biomaterials, and sensors for rapid detection of Covid-19 infection. I notice you continue to have several research topics such as new photonic glasses, and glass-ceramics, new rare-earth doped glass formulations for their unique magneto-optical and

luminescent properties, and oxyfluoride glasses/glass-ceramics. There of course are other research programs, such as high ballistic impact resistant glasses for armor, Tv, smartphone displays and dental restoration, and fast ion-conducting glasses for batteries. Among application-driven topics, you have explored the use of large glass databases such as the SciGlass, artificial intelligence (and neural networks), and atomic computational-driven schemes such as the molecular dynamics to determine what is an optimum glass or glass-ceramic for a given application.

- (2) *Outreach programs.* Your “Technician in Glass Production” program is commendable. There is a large shortage of “skilled labor” to assist professional engineers in glass manufacturing and laboratory assistants for mature researchers. I had suggested a similar “1-year” “diploma program at Alfred University several years ago. It would have modeled that given at Sheffield University in the 1960s. You have admitted 40 students and already graduated 32! In addition, you have conducted half-hour sessions of online video presentations to roughly 40 children. There were science comic books developed. There were theater workshops conducted and podcast series with *intriguing* topics on glass science delivered on Radio UFSCar also. (I hope you get invited by NBC or ABC!)
- (3) *World recognition.* Your team members continue achieve significant global recognition as an advanced center for glass science education and research. Your instructional courses at the Bachelor’s degree level are well-designed.
- (4) *High level of intellectual output.* Again I notice with pleasure that CeRTEV faculty and students have published 55 peer-reviewed articles in well-recognized technical journals and authored several patents on glass and glass-ceramics in the past year. Many articles have been downloaded by researchers. from the Journal of Non-Crystalline Solids.
- (5) *Development of online teaching.* Covid-19 forced all of us to develop online non-contact courses for the students. This CeRTEV did well.
- (6) *Technology transfer.* You appear to have made substantial progress in efforts to transfer technology over to the private enterprise. This is a positive response to my 2017 suggestion.
- (7) *International collaborations.* As noted above, Dr. Vladimir Fokin of St. Petersburg visited CeRTEV.

Areas for potential growth

- (1) *Glass and glass-ceramics for COVID-19*. It is important to develop optical fibers, and solid-state sensors for monitoring COVID-19 infection and reusable glass and glass-ceramic materials to combat COVID-19.
- (2) *Celebrating the International Year of Glass 2022*. I believe you are on the Council for the IYoG 2022 celebrations headed by Professor Alicia Duran of Spain. Congratulations. It is indeed important to make the general public aware of the good products that glass technology has developed to increase the comforts of human living. I am sure you will be organizing suitable shows and outreach to high schools to get the general public appreciate glass for all that it is.

In closing, I must say that, despite the threat of the COVID-19 pandemic past 1-1/2 years, your CeRTEV team did well in the year that went by. My congratulations. If there are any items that you wish to discuss more, please let me know. Best wishes,

Yours sincerely,

A handwritten signature in black ink, appearing to read 'Arun K. Varshneya'. The signature is fluid and cursive, with a large initial 'A'.

Dr. Arun K. Varshneya
President & CEO

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