

Report on CERTEV activities (2019-2020)

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. Two years after its renewal, in 2020, its production is still outstanding as shown below.

In the field of fundamental and academic research, the effort is focused on tackling questions dealing with the thermodynamic and kinetic foundations of glass formation, relaxation, and crystallization towards glass-ceramics. Application-oriented research is not forgotten with the aim to use the insights on composition-structure-property relationships 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, 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. The research carried out at CeRTEV in these fields is extremely active as attested by the large production of papers (55 in the last year). Their quality is attested by the fact that two recent publications were among the most cited ones of the JNCS in 2019. The excellent work is internationally recognized as acknowledged by numerous invited (23) and plenary (3) talks at the main national and international 2019-2020 conferences in the field. Such strong activities strongly benefit to the formation of young researchers since ~70 of them worked in the CERTEV laboratories last year with 28 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, Nippon Sheet Glass Foundation) companies while several others are under (final) discussions (CBMM (Brazil), EMBRAPII (Brazil), Engecer (Brazil)). These efforts also resulted in the successful filing of patents with the Brazilian National Institute of Industrial Property (BR 10 2019 027233-3 UNESP, BR 10 2019 027220-1 UNESP) while two other patent applications are on the way. But the most important success in terms of technological transfer is the continuing development of the spin-off company VETRA involved in the development of glasses and GC biomaterials with ingoing projects with FAPESP, obtaining of a license for one of its patent, working on another licensing, and finally recently closing supply contract deals with two national companies.

In the domain of Educational and Outreach Activities, the greatest achievement is the successful development of a course "Technician in Glass Production" which became a reality in July 2019 with the first 32 students receiving their degree, among which 70% are now working in

glass companies. CeRTEV also actively participates in the UFSCar's overall mission of educational outreach to the general public, with activities aiming at promoting science divulgation with a focus on glass and others in the framework of the EduSCar's project, aiming at improving the education system and promoting scientific education, especially towards the most vulnerable population. Many events are organized throughout the year, some of them very original and demonstrating the creativity of the organizers (Science Circus, Science Bus, Theater and Musical Presentations, Comics, Pod-casts recorded by Radio UFSCar 95.3 FM).

In conclusion, in the last year, 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, patents, contract agreements with national and international companies, continuing development of a spin-off company, creation of a technical course on Glass technology, educational activity towards young public. Through this production, the CeRTEV members confirm that they deserve the trust they have been given by renewing the Center funding in 2018.

July 13, 2020

Prof. Edgar Dutra Zanotto
Univ. Fed. São Carlos, LAMAV

In regards to the 2019-2020 Annual Report/CeRTEV

This is an excellent and comprehensive report. The materials science is world class. The educational and informational outreach is clever and creative. Outreach to the Brazilian glass industry is stronger than it has been in the past, and the creation of spin-off companies and activities in commercialization of specialty glass technologies is particularly exciting because of their potential economic impact.

The following are some notes and observations from my reading of the report.

- In the *Introduction and Overview* section (pp. 1-2), consider adding brief summaries of specialty glass tech transfer/jobs created, something of value to the funding agency. You might also consider a line or two about your service to the broader Brazilian glass industry in these introductory comments.
- For the studies of bullet-proof glasses (mechanically strong glass, p. 4), have you considered adding a mechanical engineer to your team to model the performance of multilayer composite windows? Structural analyses may help guide design. For example, may need only one hard layer (transparent glass-ceramic) as the surface of a composite stack, with conventional glass in the underlying layers.
- The work on structure/composition effects on crack resistance and hardness is quite interesting (p. 5). You say that the research relates to designing better display screens, but have you considered the impact of this work on designing stronger/better reinforcement fibers? Your expertise in liquidus temperature melt properties would be important in designing new processable compositions.
- The “Technician in Glass” training program is a marvelous addition to the CeRTEV portfolio (pp. 14-15). I hope that you will collect information from the companies about the value of this program. Testimonials about cost and time savings from companies would be important to your funding agency. Similar information could be collected from participants in the *Workshop University-Industry on Glass Materials* (pp. 24-25).
- Have you considered providing English language versions of your “glass pod-casts” (p.17), to reach a broader audience? I know that I would listen to them!
- For the *Innovation and Tech Transfer* section, it seems to me that the establishment of specialty glass start-up companies should be highlighted, along with other examples of economic activity (p. 20-21). Such returns on investment should be valued by funding agencies.

The COVID-19 section is interesting (pp. 24-41); would be interesting to know what kind of response you have received from external agencies.

Very nice work, Edgar; CeRTEV is certainly one of the most outstanding public organizations for glass science, technology, and education in the world. You and your colleagues have much to be proud of!

Cordially,



Richard K. Brow
Interim Deputy Provost for Academic Excellence
Director, Center for Biomedical Research

Aalborg, July 12, 2020

Assessment on CeRTEV in July 2019 to June 2020

In the past year, CeRTEV has achieved substantial advances in glass science and technology as well as in education. Their activities cover a large range of frontier subjects. This is particularly impressive considering the challenging COVID-19 pandemic time. These advances have been reflected in numerous high-impact scientific papers, conference talks (especially invited ones), and patents. 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.

As a member of the International Advisory Committee of CeRTEV, I had a close collaboration with Professor Zanotto and his postdoc Maziar Montazerian, which led to a comprehensive high-impact review article entitled "Understanding glass by DSC", which was published in the top journal *Chemical Reviews* (Impact factor: 54).

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 organizing training course and by initiating various events despite the COVID-19 pandemic hinderness.

Based on the outstanding research environments established in the past 5 years, CeRTEV has a huge potential to be further developed and to deliver highly original results to scientific communities and society. I wish the center to invest more effort in fundamental and interdisciplinary research in future. I believe 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

Evaluation – CeRTEV performance Report July2019-June 2020

The CeRTEV is a well known and highly respected institution in material science and among the leading institutions in the field of glass and glass-ceramic research worldwide. The high quality scientific work and output which CeRTEV produced regularly since its foundation was also continued during the last evaluation period 2019-2020. The numerous publications in renowned journals reflects this impressive continuity. The impact of CeRTEVs research is not limited to the field of glass science. Fundamental studies e.g. on nucleation and crystallization or research on bioactive materials brought important insights not only for glass researchers but for many scientists working in adjacent fields of science such as materials simulation or medical science. Important to note is that CeRTEVs research is well balanced and addresses rather academic and cutting edge topics like machine learning or molecular dynamics simulations just as traditional topics with rather applied character like the engineering of a strong and tough enstatite-ZrO₂ glass-ceramic, scouting new applications like “Engineered stones” or the investigation of structure property relationships in general. Furthermore, CeRTEVs international orientation which is reflected by its large network of international researchers and collaborations, has to be highlighted. The Center is involved in the education and advanced training of students as well as young professionals for the global glass and glass-ceramic community and therefore significantly contributes to the future of this field.

Dr. Markus Rampf

Ivoclar Vivadent AG

Head of Department / Technology Inorganic Chemistry



Nagaoka University of Technology
Nagaoka, 940-2188 Japan

Evaluation Report for CeRTEV Research Activities

14 July, 2020

Dear Prof. Edgar Dutra Zanotto

I evaluate the CeRTEV research activities (July 2019 – June 2020) as a member of the international advisory board. I understand that one of the most important agenda in CeRTEV research is to advance fundamental research and technological development in the area of glass and glass-ceramic science, leading the innovation and technology transfer in Brazil. The research group in the CeRTEV is doing the research and education very actively, and many excellent results have been obtained in the fields of fundamental research issues on glass property prediction and nucleation and crystal growth, strong glasses and glass-ceramics, bioactive glasses, fast ion-conducting glasses and glass-ceramics, and photonic glasses and glass-ceramics. In particular, I evaluate highly the CeRTEV research on the composition design of new functional glasses and glass-ceramics based on glass-property prediction and structure-property correlations. The CERTEV research leads the world of new functional glasses and glass-ceramics with high reputations. I also evaluate highly the CeRTEV activities on the education for students. Finally, I conclude that the CeRTEV is carrying out actively its agenda and produces many excellent fruits.

Sincerely yours

Dr. Takayuki Komatsu
Professor Emeritus
Nagaoka University of Technology
Nagaoka 940-2188, Japan
Tel.: +81-258-47-9313
Fax: +81-258-47-9300
E-mail. komatsu@mst.nagaokaut.ac.jp

長岡技術科学大学

SAXON GLASS TECHNOLOGIES, INC.

200 N. MAIN STREET, P. O. BOX 575, ALFRED, NY 14802

Phone (607)587-9630

www.saxonglass.com

Fax: (201)855-0643

July 13, 2020

Dr. Edgar Zanotto
Director, CeRTEV
Brazil

Subject: My observations on the activities of CeRTEV July 2019-June 2020

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 15 faculty (10 PI’s and 4 collaborators), 60 students and post-doctoral students.

To summarize, the world has been experiencing challenging times during this past year (and perhaps continuing into the foreseeable future) due to the COVID-19 pandemic. Any achievement in the past year is a brave effort on your Center’s part. But, looking forward, we must all focus our attention on understanding and fighting COVID-19 using glass materials.

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 estimating physical properties of traditional glass and glass-ceramics with emphasis on biomaterials. I notice you have several new research topics such as new photonic glasses and glass-ceramics, new rare-earth doped glass formulations for their unique optical and luminescent properties, and oxyfluoride glasses/glass-ceramics. You also initiated research on alternative methods of glass-making and nanocomposites. There of course are

other research programs, such as in ion-conducting glasses, which are well recognized. Among application-driven topics, you have explored the use of large glass databases, 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. I approve of this approach. Following my suggestion in 2017, you initiated development programs in understanding mechanical characteristics, particularly in the area of strong glasses and glass-ceramics for ballistic uses. To address the current pandemic issue, you have initiated development programs such as sensors for COVID-19 (discussed more below).

- (2) *Outreach programs.* You are presenting short courses at professional meetings for the industry professionals. Many of your efforts to bring the magic of glass science to high school-going children are well received. Having CeRTEV booth at young researchers' conference and offering the *Engineers and Scientists of the Future* each semester are good examples of the right direction. Your collaboration with Ouroboros group to bring theater and music into glass science reaching 4,200 people is admirable. Keeping pace with the new technology, your 1 minute pod-casts, your radio programs to talk about glass, and glass-comics, I am sure, are very entertaining as well as educational.
- (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 several 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. One of these, "Updated definition of a glass-ceramic" is the most-downloaded article of 2019 from the Journal of Non-Crystalline Solids.
- (5) *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.
- (6) *International collaborations.* I am pleased to note that you invited professor Jincheng Du of Texas A&M and Dr. Vladimir Fokin of St. Petersburg among others to visit you. That demonstrates your desire

to get the best education for your students with international collaboration.

Areas for potential growth

- (1) *Glass and glass-ceramics for COVID-19.* I notice that you will utilize your data-mining capabilities to obtain better estimates of infections and deaths related to COVID-19 in Brazil. I am not sure if this is a good use of your time and resources. Instead, what is more important is to develop optical fibers, and solid-state sensors for monitoring COVID-19 infection and reusable glass and glass-ceramic materials to combat COVID-19. Research on biomaterials approach to COVID-19 appears interesting. These activities you seem to have started. They need more attention. **My suggestion: develop nanocomposites with active groups attached to deliver vaccines or drugs to fight COVID-19 infection on a time-release basis.**
- (2) *Glass science book effort.* OK, here I should suggest to you again that you should organize a group at your institute to translate my third edition book, "*Fundamentals of Inorganic Glasses*", co-authored with Professor John Mauro of the Penn State University into Portuguese!

In closing, I must say that, despite the threat of the COVID-19 pandemic looming over all of us, 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,



Dr. Arun K. Varshneya
President & CEO

Assessment report for CeRTEV activities in 2019 - 2020

July 3rd, 2020

Kei Maeda
Fellow
AGC Inc.

As mentioned in this year's report (last year's one as well), three key developments, (1) results from 60 years modern fundamental database, (2) highly effective artificial intelligence for mining this database, (3) powerful theory-based and computational techniques, are indeed good drivers for recent researches of glass science and technology. CeRTEV is doing excellent activities using them as is evident from 55 scientific papers. One of the typical examples is the paper entitled "Explainable Machine Learning Algorithms for Predicting Glass Transition Temperatures" (Acta Materialia: Ref. 3), which can provide high quality estimation of glass transition temperatures even for novel glass compositions. Fundamental and/or application studies regarding glass-ceramics with wide range of standard compositions including Na₂O-CaO-SiO₂, MgO-CaO-SiO₂, MgO-SiO₂-ZrO₂ systems are very valuable from industrial view point. The review article on transparent glass-ceramics for ballistic protection (Ref. 16) was also a useful reference for researchers/engineers who want to make strong transparent products.

It should be also noted that CeRTEV started new activities to overcome the threat by COVID-19. It is very impressive that CeRTEV created a new strategy so quickly based on their technologies. I really hope that new technologies will be available near future to help people's lives and health in whole world.



**FRIEDRICH-SCHILLER-
UNIVERSITÄT
JENA**

Otto-Schott-Institut für Materialforschung

Chemisch-Geowissenschaftliche Fakultät

Christian Rüssel

Prof. Dr. rer. nat. Dr.-Ing. habil. Dr. h.c.

Lützerodaer Weg 22, 07751 Jena

Telefon: 0 36 41 447635

E-Mail: ccr@uni-jena.de

02. July 2020

Jena, 22. Juli 2020

Friedrich-Schiller-Universität Jena 07743 Jena

Comments on the report:

CeRTEV - Center for Research, Technology and Education in Vitreous Materials
Report July 2019 – June 2020

The center for Research, Technology and Education in Vitreous Materials works very well.

In the past year, they performed an impressive piece of work dedicated to numerous fields of glass science and also glass technology. Here, especially the work on ionic conductors and biomaterials should be highlighted. Ionic conductors are nowadays one of the most challenging fields of glass science because of the utilization in energy storage. Biomaterials are also of increasing importance not only due to their use as material for bone replacement, but also in numerous other fields, where a specific interaction of an inorganic material with a biological species is required.

A specialty of the Center is that fundamental science, such as spectroscopy, nucleation and crystallization theory and molecular dynamics is connected to the search for special compositions, which is the “heart” of glass chemistry and (applied) glass science and last not least to technological aspects. Due to the large scale of the Center and the very different backgrounds of the respective principal investigators, very different expertises offer a large synergetic potential.

The outcome of the Center is very impressive: the number of the original publications as well as review papers and the quality of journals they are published, the number of talk given in national and international meetings. Very important are also the teaching activities as well as all the 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 corona which started in the past few months. Here, the synergies only possible in a center of hypercritical size are decisive.

All together, the Center is a great success.

Christian Rüssel

Quebec City, July 20, 2020

Prof. Dr. Edgar Dutra Zanotto
Director CERTEV Centre
Universidade Federal Sao Carlos
Brazil,

Comments on the CERTEV Annual report for the period July 2019 – June 2020

The report describes the research activities for the period July 2019 – June 2020 regarding the development of new active glasses and glass ceramics with applications to reinforcement of materials, bioactive glasses, ion conductive materials and photonic glasses. The report highlights the progress of the development of new glass and glassy materials with promising properties in areas with great interest for industry.

The progress of the research activities shown the implications of several professors, researchers, Pos-doc, graduate and undergraduate students. We may note the implications of this team in basic and applied science with the participation of national and international industries. Particularly, I would like to congratulate the team for extending their research with international industrial research partners as NSG, AGC, Schott and Ivoclar which indicate the excellence of the team and also the qualities of the research realized in Brazil.

The impact of the implication of the team in the diffusion of glass science through the organisation of several events, courses, videos and exhibition results not only in the attraction of several young scientist but also in the dissemination of this area at different Brazilians University not limited to Sao Paulo state but also to the rest of Brazil. I can say, presently few research center in the world has such impact as CERTEV comparing with USA, Japan and Europe. Of course, some research center is emerging in China but far away from the excellence research performed by CERTEV.

In my opinion all the research activities are well organised and supported, and my suggestion to CETEV are:

- 1- Enhancing the Co-tutelle thesis with partners in Europe, USA and others countries;
- 2- Based on the expertise of the team and with an **EXTRA-Funding from FAPESP agency**, create a Join research lab with an International center on the development of new generations of glassy materials for car batteries;
- 3- Extend the Artificial Intelligence and Machine Learning (ML) algorithms activities to the optical glass properties.

CERCP

Chaire d'excellence en recherche du Canada
sur l'innovation en photonique

Canada Excellence Research Chair
in Photonic Innovations

Finally, congratulation of the excellent research work performed at CERTEV during this period.

Sincerely,



Younès Messaddeq
Full Professor and holder of the
Canadian Excellence Research Chair in Photonic Innovations

Universität Erlangen-Nürnberg, Lehrstuhl Biomaterialien Cauerstr. 6, 91058 Erlangen

FAPESP

The São Paulo State Research Foundation

**Department für Werkstoffwissenschaften
Lehrstuhl für Werkstoffwissenschaften
(Biomaterialien) – WW 7**

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

Cauerstraße 6, 91058 Erlangen
Telefon +49 9131 85-28601
Telefax +49 9131 85-28603
aldo.boccaccini@ww.uni-erlangen.de
<http://www.biomat.techfak.uni-erlangen.de/>

Erlangen, 06.07.2020

CeRTEV - Center for Research, Technology and Education in Vitreous Materials Report July 2019 – June 2020

Dear Sirs,

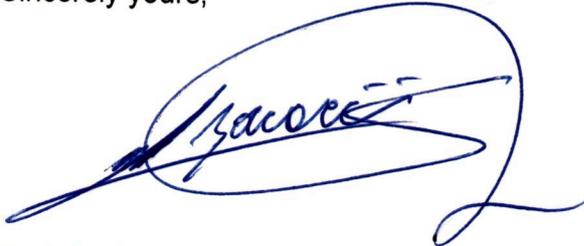
I am glad to provide feedback on the annual report (July 2019 – June 2020) of CeRTEV - Center for Research, Technology and Education in Vitreous Materials. The report shows an excellent level of advancement in the activities of the Centre, in particular in the core area of fundamental research on glasses and glass-ceramics, but also in important application areas such as “Bioactive Glasses”. Research on bioactive glass is at the core of our activities in my Institute at the University of Erlangen-Nuremberg and we follow closely the developments and innovations coming from CeRTEV. Here I would highlight the recent progress introduced by CeRTEV in the field of machine learning approaches and other modeling methods to design bioactive glass compositions. Such “smart” approaches are not only of highly scientific interest but also of practical relevance, considering the increasing trend in developing bioactive glasses with complex chemical composition where addition of biologically active ions is central. I anticipate that the approaches suggested by the CeRTEV researchers will transform the way we design and produce such bioactive glasses, which is routinely done by a “trial an error” approach. Here I think that a close link with key laboratories worldwide, including our Institute in Erlangen and also the FunGlass Centre in Trencin, Slovakia, could be highly beneficial to develop comprehensive data bases that cover not only material properties but also biological outcomes of bioactive glasses so that such “machine learning” approaches can be developed further.

In addition to the impressive number of high quality outputs coming from the research activities of the Centre, I am impressed by the outstanding activities that the members of the Centre have carried out in several other aspects, namely i) outreach activities directed to the general community using several communication platforms, ii) establishment of new cooperation

agreements with industry, and iii) promotion of innovation and technology transfer. I also recognize the planned contribution of CeRTEV's experts to tackle COVID-19 emergency by proposing a number of highly interesting and relevant projects for the period 2020-2021. In this regard, I would suggest seeking stronger collaboration with laboratories across the world engaged in similar research.

I congratulate Prof Edgar Zanotto, CeRTEV director, and everyone at CeRTEV for the tremendous number and the quality of outputs achieved during the last year, that make CeRTEV a leading Centre for glass research and education worldwide, and I wish the Centre further successes in the broad range of activities planned for the next period.

Sincerely yours,



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

----- Mensagem original -----

Assunto: Re: CeRTEV annual report - We need your assessment, 15-30 lines

Data: 2020-07-12 18:18

De: Himanshu Jain <h.jain@lehigh.edu>

Para: Edgar Dutra Zanotto <dedz@ufscar.br>

Dear Edgar,

I hope you, the family and friends at CeRTEV are keeping well and safe. I hear all these scary news of pandemic going out of control in your country as in ours - it is a natural disaster but the willful mishandling by our leaders is nothing less than a crime against humanity and history.

My apologies for keep forgetting and thus delaying responding to your multiple emails and reminders. It is by no means any indication of my lack of interest in CeRTEV and its progress, but just a combination of urgent deadlines and some unexpected administrative jobs dumped on me. Anyway, below are my remarks on its most recent report. I hope that it is not too late and that they are helpful. Please let me know if you want my comments on a letterhead or need additional information.

I hope that the pandemic will be controlled in coming months if not sooner so that we can resume normal life. Eduardo Ferreira and I have been planning on some exciting collaboration on electric field induced processing of glasses and ceramics, and he was all set for sabbatical leave at Lehigh last Spring, but then all fizzled out. It was timed to coincide with the sabbatical visit of Prof. Rachman Chaim from Technion, Israel, and that too is postponed. Anyway, stay safe and please give my regards to Lucia.

Kind regards,

Himanshu

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It has been a pleasure to catch up with the progress made by CeRTEV faculty, researchers and students since the last report. They have continued to be highly productive and leading the overall output of glass research in a number of areas. The Center has by and large remained focused on five key areas of glass research: 1. Fundamental research, 2. Strong glasses and glass-ceramics, 3. Bioactive glasses, 4. Fast ion-conducting glasses and glass-ceramics, and 5. Photonic glasses and glass-ceramics. This seems to be a correct strategy of not trying to do everything, which would naturally translate to spreading too thin. However, there has been significant evolution of ideas within each of these topical areas, leading to impressive advancements, which are published in over 50 peer-reviewed, high quality technical journals - a couple of them becoming top cited or downloaded review articles! This is a clear indication of the impressive success of this Center for which they are congratulated.

With regard to broad impact, CeRTEV's training of the workforce for the glass industry has produced the most concrete results. Designing a curriculum, getting approved and implemented to the point of having dozens of students through graduation is a remarkable achievement for the organizers, especially Ana Rodrigues and Karina Lupetti to be proud of. They have also been very effective in teaching the basic concepts of glass science of the general public through a cartoon series. Keep it up!

I am impressed by the ability of the members of the group to respond to emerging needs and opportunities, as indicated by the response to FAPESP's call for understanding and mitigating the Covid-19 pandemic. Obviously, it is a highly complex and mostly unknown area of materials research and the impact of any outcome will depend on the coordination

with virologists and other potential users of the information. With regard to opportunities for research, there is increasing interest in applying machine learning and data science to materials research. I would like to suggest to consider applying these computational tools to the laboratory research projects being carried out within CerTEV. Such an integration of data analytics and physical experiments should significantly enhance the scope of research at CerTEV.

+++++

Himanshu Jain
T.L. Diamond Distinguished Chair in Engineering and Applied Science and
Professor of Materials Science and Engineering
Director, Interdisciplinary Research Institute for Functional Materials
and Devices (I-FMD)
Lehigh University, 7 Asa Drive
Bethlehem, PA 18015, USA
Phone: 1-610-758-4217 [2]. Fax: 1-610-758-4244 [3]. Secretary:
1-610-758-4220 [4]
Web: <http://www.lehigh.edu/~inmatsci/faculty/jain/jain.htm>

Assessment of CeRTEV Performance

Period: 2017-2018

Josef W. Zwanziger, CeRTEV IAB Member

Dept. Of Chemistry, Dalhousie University, Halifax, NS Canada

13 July 2020

My assessment is based on July 2019-June 2020 report, supplied by Dr. Zanotto. This laboratory (“laboratory network” would probably a more apt term) is exceptionally broad in its reach and range of activities. In general, as in past years, it shows excellent performance across its range. In the current report in the research section, I am particularly impressed by the structure/property correlation work on strength and fraction, where detailed structural studies are helping explain the very practical properties of glass strength and toughness. Similarly, in ion conducting glass, I am glad to see that they seem to have moved away from some of the more exotic (and expensive and less practical) additives and focused more on glass formulations that may ultimately be cost-effective.

The training and education side of the program I think has shown remarkable effectiveness, most notably through the Technician in Glass Production program that has now graduated its first cohort. This group seems to have been successful in finding placements, and we can only hope that the current global pandemic does not crush the momentum of this innovative initiative.

Finally, still in the context of the current global pandemic, it is laudable that CerteV lab directing some of its resources and expertise at projects and initiatives to try to track the viral spread and to help in finding ways to limit its growth. As the world will probably have to find ways to live with this disease for some time, it is heartening that this lab is trying to be one of the agents for change.

In summary, this network is without question fulfilling its mission, and is viewed internationally as one of the key glass research centres in the world.



Institut des Sciences Chimiques de Rennes
UMR CNRS 6226



Dr Jean-Luc Adam

Phone : 33 (0)2 23 23 62 62

Fax : 33 (0)2 23 23 66 31

jean-luc.adam@univ-rennes1.fr

Report on the activity of CERTEV in 2019

CERTEV is undoubtedly 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. 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 very high (more than 50 articles in 2019), 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, 4 patents for instance in 2019 in the fields of bioglasses and photonic glasses.

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

The international recognition is well accounted for by the very high number of oral presentations, and especially invited lectures (15 in 2019, a few of them cancelled unfortunately due to COVID-19), delivered by several CERTEV members in high-level international conferences. More than 10 invited talks were given at the national level. The implication of CERTEV scientists in the organization of international conferences is also outstanding. 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 (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 26 PhD thesis, either defended or in progress in 2019.

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 (32), as compared to the situation in other countries. 70 % of them were employed in their technical domain. Among the numerous 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 10th, 2020

A handwritten signature in black ink, appearing to read 'J. Adam', enclosed in a thin black rectangular border.

Dr. Jean-Luc Adam, CNRS Research Director

Report on the activity of CERTEV 2019-20

Dr. Shingo NAKANE
Nippon Electric Glass Co. Ltd.
Fundamental technology Division
Phone : 81 (0)77 537 1381
Fax : 81 (0)77 534 1727
snakane@neg.co.jp

CERTEV has been developing compositional-design methods in glass and glass ceramics materials which consist of making comprehensive database, application of artificial intelligence (neural networks) applying for mining this database, prediction of structures from molecular dynamics simulations and the calculation of physical properties. In addition, they have been developing outstanding research of glass and glass-ceramics for various applications which are ballistic protection, bioactive, ion conductors, photonic materials. They have released many original research articles to leading journals in inorganic, physics, and chemistry showed in their report. From my industry point of view, fundamental research of glass structure and theories of glass forming are impressive. Although they are very important as fundamental of R&D in industry for innovation, they tend to be low priority because long term effort would be required to bear fruit without immediate results. Other impressive point is that the fundamental researches have been done not only by experiment but also 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 fields 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.

CERTEV also develops a way for access of glass science to much broader people beyond specialists, especially to young prominent students and scientists by steady efforts with strategy of organizing seminar, short course and events.

In conclusion, CERTEV is promoting research and education internationally, and they have contributed development of the glass and glass-ceramics science by creation of fundamental knowledge and methods in this period 2019-20.

Otsu Shiga JAPAN, July 13th, 2020

中根 慎 護

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



Nippon Electric Glass Co. Ltd., 2-7-1 Seiran Otsu, Shiga 520-8639, JAPAN
<http://www.neg.co.jp/en/>

To whom it may concern

Evaluation of the report of the CeRTEV - Center for Research, Technology and Education in Vitreous Materials
Reporting period 07/2019-06/2020

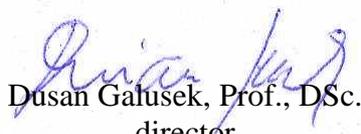
As a member of the International advisory board of the CeRTEV, I was contacted by prof. Edgar D. Zanotto, the Centre's director with the request to evaluate the report on research, educational, outreach, and innovation activities of the Centre. Based on the information provided I came to the following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

1. The Centre achieved impressive results in developing fundamental understanding of glass as a material, utilizing innovative approaches, such as machine learning based on artificial intelligence and data mining, and applying them in prediction of key properties of various glass compositions. The research activities were devoted also to development of alternative ways of preparation of glass and glass-ceramics, development of strong glasses, glasses with new functionalities, including ion-conducting and photonic glasses, and bioactive glasses. In the reporting period, these were published in 55 papers in peer-reviewed journals.
2. In the educational and outreach activities the Centre focused at education of glass specialist in the frame of the course "Technician in Glass Production", with 70 % of graduates now working in glass companies. The Centre organized also an impressive number of events generating greater awareness on glass among general public, with special focus on young generation.
3. In the field of Innovation and technology transfer, the Centre was active also in contractual research for leading world glass companies, including AGC, Ivoclar, Nippon Electric Glass, and Schott. CeRTEV created a spin-off company VETRA High-Tech Ceramic Products in Sao Carlos, preparing and obtaining patents in the field of biomaterials.
4. CeRTEV joined concentrated world efforts combating the Covid-19 pandemia, initiating 6 pilot projects related to its expertise.
5. In terms of funding, I appreciate the fact the Centre significantly increased the fraction of funding obtained from international funds.
6. The Centre is well recognized worldwide, as demonstrated by high citation response to its scientific work, and significant number of invited talks at major scientific events and conferences.

Summary:

1. CeRTEV is a well managed research Centre of international significance and recognition. The activities of the Centre cover all aspects and functions required for similar centers, ranging from excellent fundamental research anchored in deep understanding of basic physical and chemical principles, which is then successfully transferred to applied and contractual research, intensive collaboration with glass industries, and educational activities for both glass specialists and general public.

Trenčín, July 8, 2020



Dusan Galusek, Prof., DSc.
director

2020/07/07

Comments to the “CeRTEV - Center for Research, Technology and Education in Vitreous Materials Report: July 2019 – June 2020 “

The report summarizes the results of scientific and educational efforts during the last year. Similar to the previous years it is an impressive combination of basic researches, applied developments, professional training of student and postdocs, along with general educational activity.

I would like to emphasize a new approach based on new opportunities resulted from digital databases and mathematical modeling. This approach enables prediction of properties of glasses and glass ceramics resulted in dramatic decrease of number of melting and sintering experiments.

As an optical person, I would comment achievements in study and development in photonic glasses. The study covers a broad range of glass compositions and dopants for applications in lasers, luminophors, and scintillators. Very detailed study of dopant distribution in Na-W-P glasses provides restriction on maximum concentrations. Study of IR transparent doped germanate glasses provides new opportunities for upconversion sources. It could be an advice to extend this interesting research for mid IR lasers that are under strong demand for different applications. The study of scintillator glasses is very important because of fast development of non-invasive control (including tomography) in medicine, industry and security areas.

A new direction of optical properties of nanoclusters and nanoparticles revealed mechanisms of energy transfer and resulted in broadband sources in visible part of the spectrum. The study of oxyfluoride glasses with NMR and EPR methods gives a lot of new information on structure of single-phase glasses and partially crystallized ones. This is useful information for laser development. I would like to add that after a several years period, when we had to stop researches in photo-thermo-refractive glass, the glass research group at the University of Central Florida is restored and we plan to restore active collaboration with CeRTEV in the study of photo- and thermo-induced structural transformations in glass.

Thus, the results of scientific, educational and outreach activity of CeRTEV are impressive and we need to wish this center to continue its important contribution to glass science and education.

Leonid Glebov
Research Professor
University of Central Florida and OptiGrate Corp.
Orlando, Florida, USA



Prof. Dr.-Ing. habil. Joachim Deubener
Zehntnerstraße 2A
38678 Clausthal-Zellerfeld
Germany

tel: +49 (0) 5323 72 2463
fax: +49 (0) 5323 72 3710
joachim.deubener@tu-clausthal.de
<http://www.inw.tu-clausthal.de>

Evaluation of activity of CeRTEV in the period July 2019 – June 2020

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. The number of publications (55) in peer-reviewed journals remains in the top-level. Among these, the increasing fraction of joint papers of PIs (14 with 2 PIs and 3 with 3 PIs) attests that the research results have been obtained in close cooperation between the different groups within CeRTEV. 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.

Education and Outreach

PIs of CeRTEV have been very active and successful with a varied range of initiatives in training instructors, teaching students and enlightening a public without any specific background. Particularly worthy of mention in this respect is the fact that the course "Technician in Glass Production", in partnership with the Paula Souza Center, Abividro and the glass company Nadir Figueiredo, resulted in a high percentage of graduates, which received their degree. The fact that about 70% of these graduates are now working with glass companies, despite the difficult economic situation in Brazil, is the best indicator of the effectiveness and importance of CeRTEV's educational work.

Innovation and Technology Transfer

PIs of CeRTEV also stood out in activities to establish cooperation and joint projects with national industry but also with international companies in Japan (Asahi Glass Company, Nippon Electric Glass), Liechtenstein (Ivoclar Vivadent) and Germany (Schott). It should be especially noted that CeRTEV's approach: "bringing science to business" especially applies to the spin-off company VETRA. VETRA's core competencies in biomaterial processing are particularly valued because of their outstanding performance in patent granting for the formulation and use of products for clinical applications.

In summary, it can be said that the achievements of CeRTEV in all three areas are continuously outstanding and I would like congratulate the PIs for the hard work to keep this very high level of excellence in 2019/20.

Clausthal-Zellerfeld, Germany
July 08, 2020

Prof. Dr. Joachim Deubener

To: whom it may concern
From: Bruce G Aitken
Date: July 10, 2020
Subject: Review of the CeRTEV program (July 2019 – June 2020)

Once again the CeRTEV group can be justifiably proud of its publication record. It is good to see that each of the principal investigators was coauthor on at least 2 publications. It is also good to see that the two principal investigators who specialize in optical properties of glass are collaborating in this fashion, despite being located at different universities. Nevertheless, many of the principal investigators are encouraged to try to emulate the publication frequency of the program director who appears as coauthor on more than 40% of the group's output.

In the early years of the program there was little published evidence of the results of the work aimed at discovering new "structural reinforcement materials". Therefore, it was encouraging to see the article on strong enstatite-zirconia glass-ceramics by Montazerian & Zanotto that came out in the Journal of the American Ceramic Society. Perhaps patenting concerns were partly responsible for the delay in describing this study? The program director has mentioned on a number of occasions that the patenting process in Brazil is very time consuming. In view of current patent convention treaties, it is critical to be first to file a patent as opposed to first to invent, and so shortening the apparently lengthy time between discovery and patent filing is recommended.

In connection with their outreach efforts, the CeRTEV program is to be congratulated on the clear success of their "Technician in Glass Production" course with many of the graduates currently employed in industry. Finally, it is impressive to see how the CeRTEV researchers are putting science and their knowledge of glass together in an effort to stem the tide of the coronavirus. The whole world wishes them success in this endeavor.

All in all, the CeRTEV program continues to generate new fundamental understanding relevant to glass science as well as novel materials with useful properties, while maintaining a strong publication record.

Sincerely,

Bruce G. Aitken