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Glass Tower of Babel

Federal University of São Carlos attracts foreigners to research materials engineering. This is the fourth of a series of articles on scientific research in São Paulo

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The network of collaborators from abroad of the Glassy Materials Laboratory (LaMaV) at the Federal University of São Carlos (UFSCar), coordinated by materials engineering professor Edgar Dutra Zanotto, comprises researchers from France, Spain, Portugal, Germany, Bulgaria, the Czech Republic, the United Kingdom, the United States, Russia, Colombia, and Argentina. The basis of this international inclusion is the scientific and technical production of this 34-year old laboratory, one of the world's five most productive groups in the field of glass nucleation and crystallization, according to the Scopus database. The group has a strong partnership with the private sector for product development.

This explains why researchers of five different nationalities are currently working at LaMaV in São Carlos. This group comprises visiting professors and students. "Many doctoral and post-doctoral students, along with renowned visiting professors from abroad, apply for research positions and internships at LaMaV. Several of them have already worked with us. This on-going exchange is important because science is universal," says the 56-year old Zanotto, a native of the city of Botucatu in São Paulo State. Zanotto founded the research center in 1977, when he was doing his master's degree at the Physics Institute of USP São Carlos. Currently, he shares his lab coordination duties with two colleagues, Ana Cândida Martins Rodrigues and Oscar Peitl Filho.

One of the visiting professors, invited thanks to financial aid from FAPESP, is France's Jean-Louis Souquet. A retired professor from France's Institut National Polytechnique de Grenoble, Souquet has maintained a long collaborative partnership with Ana Cândida Rodrigues, ever since she did her doctorate at the École Nationale Supérieure d'Électrochimie et Électrometallurgie de Grenoble. When he retired, the French professor donated the glass melting furnace – the technology of which was not available in Brazil at the time – that he had used in his laboratory to LaMaV. "The furnace is still here and working," says Zanotto. In 2007 and in 2009, Souquet spent some time at the Brazilian laboratory. He has been back in São Carlos since August, and is currently working on a research project run by LaMaV, "Mecanismos de transporte elétrico em vidros e vitrocerâmicas" [Electrical transport mechanisms in glass and glass-ceramics]. The research project is coordinated by Ana Cândida. Nowadays, visiting professors get a stipend of as much as R\$8,536.50, in the case of researchers with qualifications equivalent to that of full professors at São Paulo State universities.

Long-lasting collaboration – Russia's Vladimir Mikhailovich Fokin, a researcher at the Vavilov State Optical Institute in St. Petersburg, will come in January 2011, also thanks to FAPESP financial aid. Fokin has been a long-time LaMaV collaborator. This will be his sixth time as a visiting professor at the laboratory – the first was in 1998. “We've worked together on about 30 papers,” says Zanotto. “He is one of the most highly experienced and prolific researchers in our field. If you type in the words “nucleation” or “crystal growth in glass” in the Scopus data base, you will see that he ranks among the world's five most productive researchers in this field,” Zanotto states.

“Fokin likes Brazil very much and is highly motivated to work in São Paulo because we have modern and up-to-date lab equipment. In addition to the equipment at our lab and at various other labs at UFSCar, he can also use the equipment at USP, Unicamp, Unesp and the Synchtron Laboratory,” says Zanotto. “The research conditions in Brazil are better than in Russia, especially when it comes to salaries and equipment, which makes us competitive and thus able to attract him,” he adds. Vladimir Fokin praises the dynamic aspects of Brazilian research, which is the opposite of the inflexibility of many traditional institutions in Europe that he is acquainted with. “I'm always deeply impressed by the enthusiasm and the will of Brazilian students to learn and do their best,” he states. “One of the most attractive aspects of my research work at LaMaV is the excellent opportunity to come into contact and establish collaborations with young researchers and students.” In his opinion, his visits to Brazil have helped him implement his scientific ideas. “And this has been possible not only because of the excellent technical conditions to conduct experiments, but also because of the friendly and productive environment in the lab,” he adds.

Israel's Itay Dyamant, who attended a post-doctoral program with a grant from FAPESP, arrived on November 1st and is the latest newcomer at LaMaV. Dyamant, who has a doctorate in chemical engineering from Ben Gurion University in Negev, had written to Zanotto asking for a post-doctoral scholarship. “I have to admit that I never answered his letter. Many young researchers send these letters of request to various places. We make an effort to bring them here and they end up accepting offers from US labs,” says Zanotto. Professor Kenneth Kelton, of Washington University, in Saint Louis, was a recipient of such letters. He suggested that Dyamant insist on contacting Zanotto again, because his research interests were tailor-made to the work being done at this UFSCar laboratory. “I told him that I would only make an effort to submit a project to FAPESP if he promised he would come. Dyamant came with his wife, having paid for the trip and the hotel accommodations, and stayed in São Carlos for a week. He enjoyed his stay and so we submitted the project to FAPESP,” says Zanotto. At present, FAPESP provides a stipend of R\$5,028.90 for post-doctoral students in Brazil.

José Luis Narvaez Semanate, from Colombia, has a degree from the University of Cauca. He has been at UFSCar since 2007. He had been recommended by a professor who had studied in Brazil and came on his own to this country to take the entrance examinations. He was given a grant from Capes after he had passed the tests. “I studied for one term as a special student before I entered the master's degree program,” he recalls. He concluded his degree in 2009 with a grant from Capes and is now attending a doctoral program, with CNPq grant. Professor Ana Cândida Rodrigues is his advisor. “It would be almost impossible to attend a graduate program in Colombia, because no such grants are available there,” he says. “Brazil offers many opportunities and LaMaV is one of the best labs in the world in this field. It has excellent infrastructure and a highly qualified technical staff that allows you to work productively,” he adds. In principle, he plans to return to Colombia to work in research after he concludes the doctoral program. “But I want to maintain my ties with LaMaV,” he says.

Source of knowledge – Jonas Kjeldsen, a Danish student, came to São Carlos for six months for his master's degree in chemical engineering, on a Danish government grant. He had heard about the São Carlos group from a German professor, Ralf Keding, who taught at his university in Denmark. "Keding had spent two years in São Carlos at the beginning of his career and knew the place and the people," says Kjeldsen. "I had the impression that the university was very serious, and sometime after I had arrived here, I knew I was right. LaMaV is a source of knowledge and I'm happy to be part of it," he says. This is a two-way street. At present, two LaMaV undergraduate students are on an internship program in Germany; in 2011, a doctoral student will spend some time in the United States and a post-doctoral student will go to Portugal and Spain.

In Zanotto's opinion, the consistency of his group is related to dedication in the same field for the last 34 years.. "We have a focus – we study glass, especially the nucleation and crystallization process. We have solid, consolidated know-how in this matter, which ranks us among the world's major groups in the field," he states. "Things here are different from other similar groups, which change their fields of interest every two or three years: they migrate from the study of ceramic toughness to super conductors, from fine films and nanotechnology to grapheme; the result is that they lack specific knowledge in these fields and have no real expertise," says the professor. He adds that his international network is the result of the contacts he made while he was abroad. In the early 1980s, he did his PhD at the University of Sheffield in the United Kingdom. He also attended research internship programs at the University of Arizona, in the United States (1987), at the International School of Advanced Studies in Polymer Science of the University of Ferrara, in Italy (1993), and at the University of Florida, also in the United States (2005). "In addition, I made international contacts during congresses and incorporated contacts made by my fellow colleagues and students," he says.

LaMaV has made several important contributions to the fields of basic research – nucleation and the growth of crystals in glass and the physical and chemical properties of glass – all of which are applied in glass-ceramics . Examples of basic research include two papers by Zanotto, published in the *American Journal of Physics* in 1998 and 1999. The topic of the first paper, commented on in *Science*, deconstructed the myth that medieval churches such as Notre-Dame, are proof that glass can flow at room temperature because the glass on their stained glass windows is thicker on the base than at the top. He does not disagree that glass is a viscous liquid. However, he proved that it would take millions of years for glass to flow to the point of achieving the thickness observed in the churches. Based on his analysis of the composition of 350 medieval stained glass windows, he concluded that the differences in the given thickness occurred only because of defects in the manufacturing of the glass.

In the field of applied research, the laboratory has made important contributions to the development of glass-ceramics, a sophisticated material with a non-porous crystalline structure that is based on glass and can be used to manufacture artificial bones and teeth, substrates of hard disks for laptops, mirrors for giant telescopes, luxury flooring, transparent, heat-resistant cooking pans, and plates for modern electric stoves that replace the traditional gas burners (see *Pesquisa FAPESP* issue 76).

Industries –LaMaV also has close cooperation ties with industries. Two dozen research and development projects were conducted in the last 20 years in conjunction with more than 40 companies, including Pirelli, Usiminas, Companhia Baiana de Pesquisas Mineraias (CBPM), Alcoa, Nadir Figueiredo, Saint-Gobain (France) and Optigrate (USA). The latest research project involving corporate research concerns biosilicate, a bio-active material than can bond with tooth enamel and prevent the hypersensitivity of dentine (see *Pesquisa FAPESP* issue

158). The biosilicate research led to the creation of a company in São Carlos.

Recently, international recognition of the research work conducted in the lab came in the form of an invitation from the Elsevier Publishing Company for Zanotto to become one of the editors of the *Journal of Non-Crystalline Solids* (JNCS), the leading publication in the field of research into glassy materials and soft glass. As of October, Zanotto has become one of the journal's editors, along with B. G. Potter, from the University of Arizona, and J. W. Zwanziger, from Dalhousie University. This is the first time that a foreigner has taken on this position. The five former editors of the journal in the last 50 years were all Americans. According to Zanotto, the fact that he was invited for this reflects the reputation of LaMaV, "which is on par with that of the most reputable international labs specializing in this field. We hope that this will help attract more funding and bright students and collaborators from Brazil and abroad."