

Germany

## Chair of Ceramics at RWTH Aachen University: Materials for the Energy Transition

Prof. Jesus Gonzalez-Julian (Fig. 1) has held the Chair of Ceramics at RWTH University of Aachen since September 2021, having succeeded Prof. Rainer Telle. Prof. Jesus Gonzalez-Julian (JG) has focussed the Institute's ceramic department on the synthesis and processing of high-performance ceramics as well as the characterization and testing of refractory ceramics. As he assumed office, the Institute was also able to move into the long-planned, new building (Fig. 2) on the Forckenbeckstrasse campus, which it shares with the Chair of Glass (Prof. Roos). Together with Thorsten Tonnesen (TT), who focuses on the field of refractories and deputized for Prof. Telle for two years after he retired, we were able to find out about the changes at the department.



**Fig. 1** Prof. Jesus Gonzalez-Julian

**cfi:** *You worked previously at FZ Jülich. What new topics have you brought to the institute?*

**JG:** My research focuses on the development of new ceramic compositions, from high temperature materials like MAX phases, high-entropy oxides and refractory compounds to bioceramics, including 2D materials like graphene and MXenes.

The term MAX phases refers to ternary compounds that contain a transition metal (M), a main group element (A) and either carbon or nitrogen (X). I don't want to go into technical details here – only this much: these are new ceramic materials that can withstand very aggressive working conditions. These aspects are very important for many new applications in power generation (gas turbines, fuel cells, hydrogen production, solar thermal energy). Key feature of these materials is the high corrosion and oxidation resistance.

Another of our focus topics is cold sintering. This is about substantially lowering energy consumption in the production of oxide ceramics. It is possible to get below 250 °C if you work with a low water content and high pressures (50–300 MPa). We are well

equipped here with installations such as hot presses, spark plasma sintering systems, vacuum furnaces, etc., and have extensive experience in the controlled sintering of ceramics.

Moreover, in future we want to address biomineralization – producing living organisms based on biomaterialization of inorganic materials. Understanding living organisms, we want to synthesize technical ceramics at low temperatures. We are developing new materials and want to bring together fundamental research and applied science.

**cfi:** *How will the established field of refractories be integrated?*

**TT:** With this field, we can contribute significantly to the necessary innovations in high-temperature technology. We have measurement systems for up to 2000 °C and can conduct thermodynamic analyses. In situ corrosion measurements and the determination of thermomechanical properties are established at the institute. Refractories are needed as soon as extreme conditions prevail in industrial processes. Refractories also play a key role, for example, in hydrogen technology.

Besides refractory materials themselves, engineering is also important. For that reason, we also conduct intensive FEM analyses of refractory linings. Newer topics here are the recycling of refractory materials and lifecycle analyses. In the scope of the strategic topic of energy transition, it is on a par with the high-performance ceramics mentioned earlier. Naturally, we are working with the approach of not only making the materials but also the process engineering more sustainable.

**cfi:** *Besides research, teaching is another one of your permanent tasks. How have you been getting on in this new area of work?*

**JG:** That's really good fun. With me being 39 years old, the difference in age to the students is not that big. The students are relishing the return of in-person events at long last – which is hugely important. We are nevertheless integrating online tools (interposed questions by mobile telephone, webinars, etc.). I should also like to point out a relatively new area of work that Prof. Telle had already established, that is additive manufacturing.

To enable our students to engage in creative, independent work, we give them the opportunity to get actively involved in the



**Fig. 2** The new building of RWTH Aachen

3Deramics EXPLORATION LAB. That is not only possible in the scope of practical placements. The students can really work freely. That ranges from self-designed tests to bachelor and master's theses. We also want to offer the lab to students in other fields because we foster interdisciplinary work. As a small institute, we have to be a bit different to get young people interested in our field. We advertise with topics that motivate young people like energy transition, recycling and sustainability. We have to explain how important material sciences are for these topics. Our beautiful new building with the new equipment is one good argument.

**cfi:** *With the Institute's expertise, you have always been active in FIRE, the global network of universities, institutes and companies in refractories. How is that being continued?*

**TT:** We are very active – it was only in June 2022 that we hosted the last Summer School.

The Chair will maintain this success with fundamental and applied research with industrial partners. In refractories we have cultivated these partnerships very intensively and successfully, too, for years.

**cfi:** *Are there already any new research projects?*

**TT:** We currently working on three EU project applications, one has now been approved. This is topic within the EU MSCA doctoral network: CESAREF (Concerted European Action on Sustainable Applications of REfractories, [www.cesaref.eu](http://www.cesaref.eu)). In addition, from 2023 we will be involved in two further EU Horizon joint projects with refractory topics: HyInHeat – Hydrogen Technologies for Decarbonization of Industrial Heating Processes and TWINGHY – Digital TWINS for Green HYdrogen Transition in Steel Industry.

Generally, we shall be working intensively on the subject of hydrogen. We have already started setting up a hydrogen laboratory and we shall expand this and make it more attractive with new projects.

**JG:** It is important to me that the Department of Ceramics at RWTH University of Aachen steps up collaboration on all levels, from universities to industrial partners. In the first phase, however, consolidation within the department and a certain amount of reorganisation have been very important to me.

Being under one roof with the Department of Glass, we have very good synergies – also because we are running the new and expensive equipment together. As we are working together actively on the issue of energy transition, I think that we are also interesting as partners for industry and applied science. We want to strengthen and further expand the existing national and international network.

**cfi:** *Thank you for talking to us.* KS



**Fig. 3** View into the labs