

NSF-PIRE-PDC NEWSLETTER

JANUARY-NOVEMBER 2019 | VOLUME 2



Attendees of the second annual NSF-PIRE-PDC workshop, held in Boulder, CO, from July 15-19, 2019.

THE PDC COMMUNITY

Building on last year, our project headed into this year with a full head of steam. Academia and industry have come together to form a cohesive unit with a laser sharp focus on creating the next generation of polymer derived ceramic (PDC) materials.

Our community keeps growing, with new collaborators, students, and private and public companies coming on board.

We gratefully acknowledge the financial support from the National Science Foundation (NSF), for bringing this PDC community together.

-Prof. Gurpreet Singh, PIRE PI

ANNUAL WORKSHOP

Our second workshop was held in Boulder, CO, from July 15-19. Read more about it on page 2.

RISHI TURNS 75

75 years young, that is! A symposium was held in his honor for his work in the field of materials science. Page 2

ON THE MOVE

Alexandra Navrotsky has taken up a new position at Arizona State University. Read about it on page 3.

ANNUAL WORKSHOP

The second annual workshop was held in Boulder, CO, from July 15-19, 2019. Over 45 attendees from academia, and 10 attendees from industry had ample opportunities to network. The workshop attracted international attendees from Europe and Asia. Academics were able to describe their research, while industry attendees were able to communicate their manufacturing needs. A key focus area of the workshop was to translate academic research to meet industrial needs.

The workshop was designed to take a break from science, with day trips to Rocky Mountain National Park (hiking), and Lyons (bluegrass music festival).



NSF-PIRE students at the workshop in Boulder, CO. L to R Top row- Sophie Justus (K-State), Shakir Bin-Mujib (K-State), Aly Badran (CU-Boulder). Middle row- Jake Regler (Lehigh), Spencer Dansereau (CU-Boulder), Zhongkan Ren (K-State), Davi Soares (K-State). Bottom row- Ben Robles (CU-Boulder), Federico Toigo (U-Padova), Karissa Cordero (UT-Arlington), Susana Aguirre-Medel (UT-Arlington).

RISHI TURNS 75

Materials scientists and industry professionals gathered in University of Colorado, Boulder's Williams Village Building on July 19 for a symposium to honor the career of Dr. Rishi Raj. It was an opportune time for the symposium as it was Raj's 75th birthday celebration as well.

The symposium was attended by many former students, friends and colleagues of Rishi, several of whom presented at the symposium. "Have fun doing research and make lasting professional friendships", and "Treat your research group as family", were some of the lessons that his students still remember.

Dr. Ralf Riedel was able to spring a surprise on Rishi Raj. Rishi was stunned to see his friend and collaborator of many years turn up unexpectedly and join him in his birthday celebrations. Former student Dr. Sandeep Shah of Boeing gave an overview of the early days of work on PDCs in Raj's lab.



Left: Rishi with Ralf Riedel. Right: Rishi with colleagues from Harvard days- Harold Frost, Ray Baughman, and John Allegra.



The symposium in honor of Rishi was attended by many of his friends, colleagues, and former students.

ON THE MOVE

After several months of discussion with Arizona State University (where she was a faculty member from 1969 to 1985), Dr. Alexandra Navrotsky has accepted a professor position at Arizona State University.

In addition to the professorship, Navrotsky will be the director of a new initiative, called Materials of the Universe (MotU), at Arizona State University. The initiative includes a new center and hiring faculty, which tie together the School of Molecular Sciences (Chemistry, Physics, the School of Earth and Space Exploration, and Engineering). The center provides the opportunity to build collaborations, graduate and undergraduate programs, both in MotU and in the broader materials context.

Navrotsky began her new position on October 1st, 2019. However, for the next few years, she will continue her existing experimental research program, grants, mentoring students, and postdocs at UC-Davis.

Congratulations Alex!



Alex Navrotsky was featured on Science Nation, the online magazine published by NSF. Alex and her team have invented an instrument to study high temperature materials, including rare earth oxides. Alex has 950 journal publications to her credit.



Left: Alex discusses the project with NSF-PIRE partner from France, Chrystelle Salameh, at the annual workshop. Right: One last picture before Alex heads off to the Denver airport to catch a flight for her next meeting in DC.

NEWS FROM U.S. PIRE PROJECT PARTNERS

PIRE P.I., **Dr. Gurpreet Singh** filed three invention disclosures on his PDC fibers and metal matrix composite research and was awarded two US patents. Singh co-authored a review article with graduate student, Zhongkan Ren on CMCs. Recently this year, his group published a second journal article on ceramic fibers, which was the result of collaboration between Singh and PIRE partner from France, **Dr. Christel Gervais**.

Earlier this year, **Dr. Peter Kroll** was on sabbatical leave at the University of Trento, working on projects with foreign PIRE partners. During this time, he collaborated with PIRE partners at Darmstadt. The collaboration led to the synthesis of a new oxynitride of tin under high pressure. Kroll has published a total of four articles this year, which are directly related to his work on the PIRE project. Susana Aguirre-Medel, a PhD student under Kroll successfully defended her thesis, titled "Synthesis and characterization of porous and dense Silicon Oxycarbide (SiCO) ceramics".

Dr. Himanshu Jain was awarded the George W. Morey Award; the award recognizes new and original work in the field of glass science and technology. Jain is excited as Lehigh University is in the process of installing a state of the art, near-ambient XPS system for surface analysis of materials. This instrument will be used to collect data on the oxidation of PDC samples, which will serve as a model example for similar studies on the stability of many other ceramics and metals to be used in high tech applications.

Dr. David Marshall has been using deep learning methods for automatic segmentation CT images from ceramic composites that have little or no grey-scale contrast. He has successfully demonstrated automated segmentation of low-contrast CT images from SiC-SiC CMC, revealing fiber locations and other features that are difficult or impossible to discern manually.

Dr. Elsa Olivetti has been working on cost modeling of PDCs by refining process flow for each of the modules within the technical cost model. As a result of her work, major cost modeling efforts can now be linked to the researchers throughout the project.

NEWS FROM ABROAD

Our partners across the globe are hard at work, answering many important questions. It is hard to list all of their accomplishments in a newsletter. Here are a few of their incredible achievements-

Dr. Ralf Riedel co-chaired the 11th International Conference on High-Performance Ceramics (CICC) series, which was held in Kunming, China, from May 25-29.

Dr. Emanuel Ionescu authored a review paper on polymer derived ultra-high temperature ceramics with U.S. project partners Peter Kroll and Alexandra Navrotsky, and NSF-PIRE foreign project partners Samuel Bernard and Ralf Riedel.

Dr. Chrystelle Salameh hosted two PIRE undergraduate students in her lab over the summer. **Sophie Justus** from Singh's lab and **Jake Regler** from Jain's lab traveled to Montpellier to join Salameh's research group. Sophie learned about drawing PDC fibers and testing their properties, while Jake worked on 3-D printing of biomaterials. Salameh collaborated with **Drs. Philippe Miele** and **Christel Gervais** to publish a journal article in Nature Materials on nanolaminate membranes.

Dr. GianDomenico Soraru published a research paper with Peter Kroll on porous silicon oxycarbide materials. He has co-authored a second paper with Kroll's group, which is currently under review. Soraru hosted Kroll's undergraduate student, **Karissa Cordero**, over the summer as part of her research program. Karissa learned to work on polymeric aerogels made from polysilazanes.

Dr. Samuel Bernard hosted **Casey Sugie** and **Henry Anderson**, both students from UC-Davis over the summer. Bernard was selected as a Japan Society for the Promotion of Science (JSPS), fellow under the FY2019 JSPS Invitational Fellowships for Research in Japan.

Dr. Gabriela Mera co hosted a workshop in Kleinwalsertal, Austria on the synthesis, processing and nanostructure of polymer-derived ceramics and metal oxynitrides. Mera hosted **Casey Sugie** and **Henry Anderson** over the summer; Casey and Henry are working under Mera's guidance on novel SiOC ceramics.

Drs. Sanjay Mathur and **Thomas Fischer** helped organize an international workshop, focusing on bringing together final year Master students with young PhD scholars. The workshop was a binational (German-French) event, held at the University of Cologne, and supported by international chapters of MRS and ACerS.

Dr. Philippe Miele was part of the scientific organizing committee for Euroboron 8; Miele served as conference chairman and on the international advisory committee. Euroboron 8 was conducted from 24-27 June, in Montpellier, France.

Dr. Paolo Colombo was the Chair for the XVI European Ceramic Society conference, that was held in Torino, Italy from 16-20 June. Federico Toigo, a master's student under Colombo, successfully defended his thesis in Materials Engineering; Federico's co-supervisors were **Drs. Giorgia Franchin** and **Gurpreet Singh**.

Closing thoughts

We are nearing the beginning of year three of our NSF-PIRE funded project. As we progress into the heart of the project, it is amazing to see the amount of progress made. The workshop which was held in Boulder, CO, is a testament to the fact that more people from academia and industry are getting on board with the project. Not only did more people attend the workshop, the content of the presentations was more expansive than the first workshop. Our next workshop will be held at the Darmstädter House in Hirschegg, Austria (which happens to be part of TU-Darmstadt), from August 16-20, 2020. This will be a great opportunity for us to network with many of our European and international partners.

The project as a whole, exceeds the sum of the parts; our project is truly multidisciplinary. We have experts in the field of preceramic polymers, high-temperature materials, thermodynamics, glasses, computational chemistry, and materials sustainability. To see such an amazing collaboration come together to produce the next generation of polymer derived ceramic fibers is truly inspiring. These experts are mentoring the next generation of polymer derived ceramic scientists. This year, we have four undergraduate and ten graduate students in the program who are advancing novel and ground-breaking research, at a pace unseen in the U.S. in decades. The research speaks for itself, as many of the investigators and students are being recognized nationally and internationally for their work. Congratulations to Susana Aguirre-Medel (PhD), and Federico Toigo (Masters), to become the first two graduate students in our project to successfully defend their thesis.

It was an honor to be part of Rishi Raj's 75th birthday celebrations. The turn-out for his birthday was an indication of how many people have been positively affected by Rishi. To see colleagues, friends and students who have worked with him for over 40 years, make the trip to Boulder was a testament to Rishi's knowledge, charm and wit. As always, he was a great host; opening his home to all workshop attendees, and having food and drinks on hand to satiate people's appetites after long days of learning at the workshop. It was truly fortuitous to be part of the crowd, an experience which I will remember for many years to come.

Season's greetings and warm wishes from all of us in Kansas. We hope you wrap up the year on a high note and have a wonderful winter break with your family and cherished ones.

Best wishes and safe travels,

Mr. Sailesh Menon

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