NSF-PIRE-PDC NEWSLETTER

PIRE
SYNTHESIS • NANOSTRUCTURE • PROPERTIES
POLYMER-DERIVED CERAMIC FIBERS

JANUARY-DECEMBER 2021 | VOLUME 4

Screenshot of Aly Badran's PhD defense, which was presented in hybrid mode

ALL THE SMALL THINGS

Thanks to hard working scientists, we are slowly but surely making our way back to a pre-COVID world. Attending the annual meeting in-person was the first time many of us had traveled to a meeting in over a year; all it took was a couple of vaccine shots to make this happen. I am grateful for all the small things that add up to create bigger and better outcomes for humanity.

The pandemic has made the PDC community more resilient and has given us the strength to grow from change. We strive to keep this growth mindset fresh in the next couple of years of the PDC project.

Prof. Gurpreet Singh, PIRE PI

VISITING SCHOLARS:

Thanks to easing of COVID travel restrictions, Dr. Gurpreet Singh was able to host PIRE students from across the globe.

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THE FORCE IS STRONG WITH ALEX:

Prof. Alex Navrotsky is co-PI on a $13.7M NSF grant to build a one-of-a-kind high-pressure research facility.

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FOURTH ANNUAL MEETING

Our fourth annual meeting was held earlier this year in Boulder, CO.

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VISITING SCHOLARS

2021 turned out to be a busy year for PIRE P.I. **Dr. Gurpreet Singh**! Apart from mentoring two graduate students and a number of undergraduates, he also played host to several visiting scholars. One graduate student (**Joel Garcia**), and one undergraduate student (**Ellie Christman**) from Lehigh University visited his lab over the summer. Dr. Singh is currently hosting one PhD track student (**Carla Real**) from University of Campinas, Brazil, and one PhD track student (**Lokesh Vendra**) from the Indian Institute of Technology (IIT), Madras. Later this year he will be hosting a PhD track student (**Gerson Leonel**) from Prof. Alexandra Navrotsky's lab. During the summer, Joel and Ellie gained hands-on training for processing PDCs. Carla is currently working on synthesis of nanomaterials and testing their electrochemical performance, and Lokesh is working on polymers and ceramics for energy applications.

Ellie and Joel take a break from research to soak up some beautiful Kansas weather

Lokesh (L), and Carla (R), hit the ground running and are working towards publishing manuscripts from the research conducted in Dr. Singh's lab

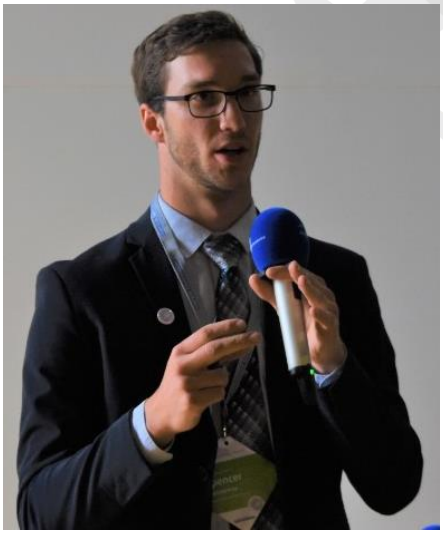
THE FORCE IS STRONG WITH ALEX

Prof. Alexandra Navrotsky from Arizona State University (ASU) recently received funding from the National Science Foundation (NSF) for a Mid-scale Research Infrastructure-1 Program to establish a national high pressure facility on the ASU campus, which will be unique in the United States. The open facility is named FORCE: Facility for Open Research in a Compressed Environment. The facility will be housed in Navrotsky Eyring Center for Materials of the Universe, and will allow U.S. and global researchers in the field of high-pressure to perform groundbreaking high-pressure experiments. The grant will provide four major pieces of equipment (a 6000-ton uniaxial Kawai-type press, a cubic press, a torsional device, and a 1 GPa gas vessel), specialized space for their installation and operation, as well as staff support. Prof. Navrotsky said, "This is the culmination of over 50 years of high-pressure studies at ASU. FORCE will be a major and long-lasting national center unique in the U.S." Congratulations, Prof. Navrotsky!

GRADUATE STUDENT NEWS

Aly Badran, graduate student under the mentorship of **Dr. David Marshall** successfully defended his PhD thesis, titled "Relating Damage to Microstructure in SiC-SiC Ceramic Matrix Composites with μCT and Deep Learning Image Segmentation". The overall goal of his thesis was to relate damage to microstructure in Ceramic Matrix Composites (CMCs). Aly is an avid outdoorsman, participating in multiple triathlon competitions. Earlier this year, Aly competed in his final Collegiate Triathlon Championship with the CU Triathlon team. The CU team won overall first place (Aly placed 5th Collegiate age group). Congratulations on the myriad of accomplishments, your bubbly personality will be sorely missed at PIRE meetings. We wish you all the best for your future endeavors!

Shakir Bin Mujib, PhD track student under the mentorship of **Dr. Gurpreet Singh** was recognized as graduate student of the month for his research on nanomaterials and energy storage. Shakir's research is focused on high performance electrode materials for electrical energy systems. On the 1st of November, 2021, Shakir and his wife welcomed baby **Rosabella**. Baby, Mother, and Father are all doing fine! Although Shakir has many outstanding accomplishments, it is safe to state that being a Father is his greatest accomplishment! Congratulations, Shakir!



Spencer Dansereau, PhD track student under the mentorship of **Dr. David Marshal**, is quite the entrepreneur. Last year, he founded Mach Electric Aerospace, which runs system-level experimental and theoretical simulations of novel air-breathing, all-electric, air-plasma propulsion systems for hypersonic vehicles. Mach Electric Aerospace has a patent-pending system, coined the MachJet. The corporation is also developing high tensile strength carbon fibers directly from gaseous CO2 via molten salt carriers; the aim of which is to create an economically feasible method of carbon capture while simultaneously bringing down the manufacturing costs of aerospace-grade carbon fibers for industrial uses. Apart from running a company and being a full time student, Spencer is an avid outdoorsman, with a penchant for scaling mountains!

Gerson Leonel, PhD track student under the mentorship of **Prof. Alex Navrotsky** is the newest PIRE graduate student. He obtained his Bachelor's degree in Chemical Engineering from Washington State University (WSU). During his time at WSU, Gerson's UG mentor suggested that working in Alex's group would be a great fit for him. The suggestion turned out to be correct as Gerson really enjoys working under Alex's guidance. In December, Gerson will visit KSU for PDC powder synthesis training. He is planning a summer trip to learn novel synthesis techniques from PIRE collaborators in Germany. Welcome to the PIRE group, Gerson!

FOURTH ANNUAL MEETING

In-person attendees at the fourth annual NSF PIRE PDC meeting held in Boulder, CO on July 19 and 20, 2021

The fourth annual NSF Partnerships for International Research and Education (PIRE) on polymer-derived ceramics (PDC) meeting was held on July 19-20 in Boulder, Colorado. The hybrid format meeting offered opportunities for team members across the globe to discuss their research and educational outcomes from the previous year. The meeting seminars covered topics in polymer-derived ceramics, high-temperature ceramic matrix composite materials, additive manufacturing of polymer composites, and ultra-high temperature materials for aerospace applications.

The meeting had a strong focus on student research and education. Graduate and undergraduate students in the PIRE project delivered oral and poster presentations on the second day of the meeting. This year, eight undergraduate students participated in various PIRE-supported summer projects.

NEWS FROM U.S. PIRE PROJECT PARTNERS

Dr. Jared Weaver was promoted to Technology Manager, Ceramics and Composites Division at General Electric (GE).

A manuscript with title "Computing the Iron–Nitrogen Phase Diagram at High Pressure and High Temperature" authored by Hanof Alkhaldi and **Dr. Peter Kroll** has been accepted for publication in the Journal of Alloys and Compounds.

Dr. Michael Cinibulk from the Air Force Research Laboratory (AFRL) was honored as one of the 2021 AFRL Fellows, for his exceptional career achievements. Dr. Cinibulk is an international authority and leader in developing refractory ceramics/ceramic matrix composites (CMCs) for

use in aerospace systems.

Aly Badran was awarded "Best student presentation", at the 12th Colorado Center for Advanced Ceramics (CACC) Student Conference.

Dr. Gurpreet Singh, and his graduate student **Shakir Bin Mujib**, were awarded the Nanomaterials and Energy Prize for 2021. The prize is offered by the Institution of Civil Engineers, U.K., to authors from both industry and academia who have produced work judged by their peers to be of exceptional quality and benefit to the civil engineering, construction and the materials science community.

Drs. Gurpreet Singh, **Paolo Colombo**, and **Guenter Motz** were co-organizer of a symposium related to precursor derived ceramic materials at the Materials Science and Technology conference (MS&T 2021) in Columbus, OH, along with lead organizer **Dr. Matthew Dickerson** of the Air Force Research Lab

NEWS FROM NON-US PIRE PROJECT PARTNERS

Earlier this year, **Prof. Ralf Riedel** was elected as Honorary Professor at the Xiamen University in China.

Prof. Paolo Colombo and his group have recently acquired (first laboratory in the world) a new printer for volumetric additive manufacturing. They are currently working on volumetric AM of preceramic polymers, with promising results.

A collaboration between **Prof. Giandomenico Soraru's** group at the University of Trento, and the Western University in Canada, led to a novel fabrication of cellular ceramics with a two-step process using PDCs.

Prof. Ravi Kumar is the PI for the Ceramic Technologies for Futuristic Mobility (CTFM), which is housed in IIT, Madras. The goal of the center is to build an innovative global hub dedicated to transformative ceramic science and technology for futuristic mobility.

PIRE project affiliate **Prof. Sanjay Mathur** was awarded the 2021 MRS Woody White Service Award.

This PIRE project is blessed to have many high caliber graduate students participate and graduate from the program. We wish them the very best for all their future endeavors. The pandemic has provided many students with the opportunity to think outside the box and venture into unfamiliar territory. As we move into the final years of this project, we hope that we will be able to continue attracting talented young people who have a passion and drive for all things related to PDCs.

A person once told me "the days are long and the years are short". This could not be more true about the current times we're in. There is so much to do; we constantly find ourselves scrambling around and juggling work and home life. Yet, before we realize it, another year has flown by. Life is fleeting, sometimes it is nice to take a step back and enjoy all the simple things in life. I hope you are able to take a few moments for yourself during the winter break. Carpe Diem! Sailesh Menon

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