Materials Chemistry Seminar

Friday, December 8, 2023
11:30 a.m. ~ BRWN 4102

"Ultrawhite Paints for Sub-ambient Radiative Cooling: Materials, Physics, and Climate Crisis Mitigation"

Dr. Xiulin Ruan is a professor in the School of Mechanical Engineering and Birck Nanotechnology Center at Purdue University. He received his B.S. and M.S. from the Department of Engineering Mechanics at Tsinghua University, in 2000 and 2002 respectively. He then received an M.S. in electrical engineering in 2006 and Ph.D. in mechanical engineering in 2007 from the University of Michigan at Ann Arbor, before joining Purdue. His research and teaching interests are in predictive simulations, scalable manufacturing, and multiscale characterizations of thermal transport materials and systems. He received the NSF CAREER Award in 2012, Air Force Summer Faculty Fellowship in 2010, 2011, and 2013, ASME Heat Transfer Division Best Paper Award in 2015, the inaugural School of Mechanical Engineering Outstanding Graduate Student Mentor Award at Purdue University in 2017, University Faculty Scholar of Purdue University in 2017, Guinness World Record in 2022, South By Southwest (SXSW) Innovation Award for Sustainability in 2023, and the Brillouin Medal from the International Phononics Society in 2023. He is a fellow of the American Society of Mechanical Engineers and currently serves as an associate editor for ASME Journal of Heat and Mass Transfer.

Professor Xiulin Ruan

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Abstract:

Cooling consumes significant amount of power and contributes to urban heat island effect and global warming. Radiative cooling, a passive cooling method that reflects solar irradiation and emits infrared heat, both to deep space, has the promise of not only saving energy but also directly cooling down our planet. In this talk, I will describe our invention of ultrawhite paints that show remarkable below-ambient cooling under direct sunlight, the physics behind it, and the implications for energy savings and climate crisis mitigation. We have fabricated CaCO3-acrylic, BaSO4-acrylic, and hBN-acrylic paints that reflect 95.5%, 98.1%, and 97.9% of sunlight respectively. Together with high emissivity in the sky window, these paints emit more infrared heat than the absorbed solar irradiation, cooling the surfaces up to 4.5 °C below the ambient temperature during noon hours and achieving a cooling power up to 117 W/m2. Our theoretical analysis show that such high performance is accomplished via pushing a few factors to the limit simultaneously. We model the applications of the paints for building envelopes, and show significant potential for energy savings and climate crisis mitigation.

Reference Materials:
https://pubs.acs.org/doi/10.1021/acsami.1c02368?ref=pdf
https://doi.org/10.1016/j.xcrp.2022.101058
https://doi.org/10.1016/j.xcrp.2020.100221