Thermal Coloring: Manipulating the Spectrum of Thermal Transport for Thermophotovoltaics, Solar Power, and Radiative Cooling

The ability to selectively control the spectrum of thermal radiation by manipulating materials chemistry and nanoscale structure holds promise for a range of energy applications including power generation and storage, and thermal management of buildings. In this talk, I will discuss two approaches for selective radiative heat transfer and their applications. The first utilizes nanoporous materials, such as aerogels, where selectivity is based on how far radiation travels within a material. By making low-energy photons travel long distances, we show how these materials can improve the efficiency of concentrated solar power and passive radiative cooling. The second utilizes nanophotonic materials, where selectivity is based on the interaction of thermal radiation with wavelength-scale structures. Our ongoing efforts are aimed at designing thin-film thermophotovoltaics (TPVs) that recycle long-energy photons back to the heat source, while trapping photons produced by radiative recombination. We have recently demonstrated recording-setting photon recycling properties, a key metric for high-performance TPVs. This level of spectral control is poised to enable conversion efficiency exceeding 40% (heat-to-electricity). Successful development of thin-film TPVs with reuse of growth wafers has the potential to enable competitive costs of approximately $0.1/Watt and displace a larger fraction of primary energy use compared to centralized power generation. With integration of thermal storage, TPVs can also become an important part of energy storage systems and may lead to increased adoption of intermittent renewables.

Bio: Andrej Lenert is an Assistant Professor in the Department of Chemical Engineering at the University of Michigan. His interests lie at the intersection of heat and mass transfer, optics, and nanomaterials. He completed his PhD at MIT in 2014, under the supervision of Evelyn Wang. He was then a postdoctoral fellow at the University of Michigan, working with the Nanoscale Transport Lab and the Center for Photonic and Multiscale Nanomaterials. In 2016, he was named to the Forbes 30 under 30 list in Science for his contributions to the field of thermal photovoltaics. This work was also cited as one of the “10 Breakthrough Technologies of 2017” by the MIT Tech Review.