Metal–Organic Thermal Materials

Jarad A. Mason, Department of Chemistry & Chemical Biology, Harvard University

In this talk, I will describe recent efforts by my group to manipulate the thermal properties of metal–organic materials for solid-state cooling and thermal devices. First, I will discuss how the thermally induced expansion of certain classes of metal–organic materials, including two-dimensional hybrid perovskites, can lead to large barocaloric effects that provide exciting opportunities for solid-state cooling. Efficient barocaloric cooling requires materials that undergo reversible phase transitions with large entropy changes, high sensitivity to hydrostatic pressure, and minimal hysteresis—the combination of which has been challenging to achieve in existing barocaloric materials. Additionally, I will discuss initial efforts in my group toward understanding the thermal conductivity of two-dimensional hybrid perovskites. While manipulating the thermal transport properties of these materials is crucial to realizing their full potential in thermal applications, much remains to be understood about the chemical and structural factors that influence thermal transport in two-dimensional perovskites at a molecular level. Through systematic investigations using the frequency-domain thermoreflectance (FDTR) technique, we provide new insights into how chemical tuning of the organic–organic interface in two-dimensional perovskites influences thermal transport, highlighting the important role of acoustic phonons.