Device Scale 2D Magnetothermal Transport from Maskless Direct-write Lithography

Stephen M. Wu
Department of Electrical and Computer Engineering
Department of Physics and Astronomy
University of Rochester
Rochester, NY 14627
stephen.wu@rochester.edu

The number of interesting two-dimensional layered materials with unique electronic, magnetic, structural, and topological phases within the transition metal dichalcogenide family is large and becoming more technologically relevant. The need for basic materials properties characterization at the micro/nanoscale for this class is important and will likely become more important when exploring dimensionality effects as we reach the monolayer limit. Traditionally, only electronic transport and optical properties have been well explored in this domain, but there are significant advantages to looking at the thermal and magnetothermal characteristics that can give additional insight into the magnetic, electronic, and topological degrees of freedom that are otherwise inaccessible. Here we introduce a fabrication method using direct-write laser photolithography to pattern on-chip magnetothermal devices on 2D materials systems. Using this technique, we are free from relying on large area 2D materials systems, and have the flexibility to explore exfoliated flakes, which still provides the highest quality samples. The flexibility and sensitivity of this method allows for fast turn-around time, and high throughput when characterizing classical magnetothermal properties, such as the Nernst effect, as we reach the 2D limit. We will explore multiple 2D materials systems and highlight some exciting prospects that these types of thermal devices may enable.

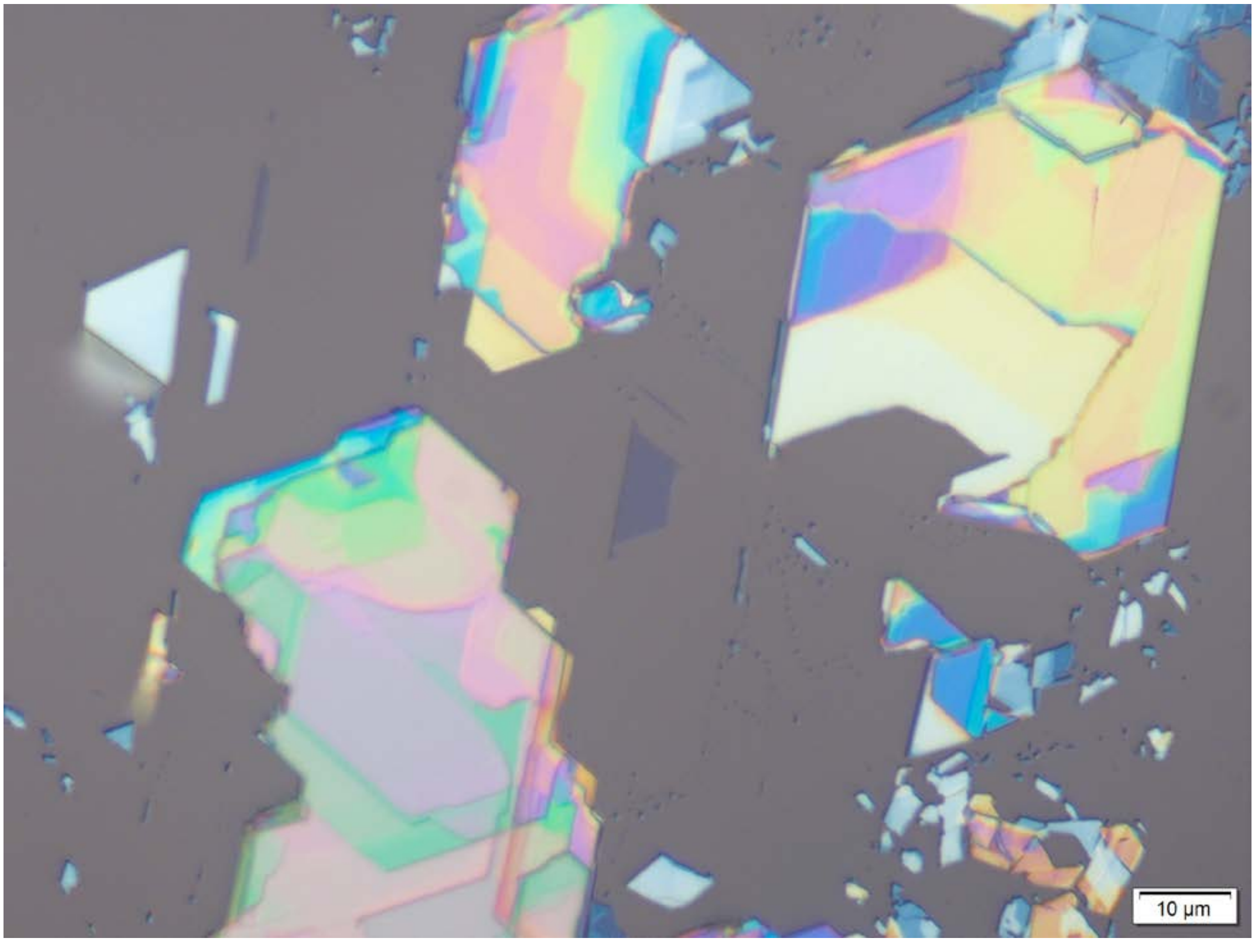

Figure 1: Micrograph of exfoliated antiferromagnetic $MnPS_3$ on SiO_2 (90 nm), different colors represent different thicknesses with varying magnetic properties as dimensionality is reduced. Magnetothermal characterization can be used to elucidate these changes.