Scaling ceramics and metals to nanoscale dimensions substantially alters their phase stabilities and phase diagrams with tremendous consequences for the manifestation of unique physical phenomena. Such new physical phenomena that oftentimes have no parallels in the bulk can be utilized to fabricate novel functional materials with applications for logic circuitry, "smart windows", photocatalysis, and electrochemical energy storage. In this talk, I will focus on our recent results on the influence of finite size and doping on the metal-insulator phase transitions of the binary vanadium oxide VO$_2$. We have achieved substantial tunability of the critical transition temperature between -20 and 70°C through control of dimensionality, morphology, and dopant concentration in hydrothermally prepared single-crystalline VO$_2$ nanostructures. The tunability of the phase diagram portends applications of these materials as dynamically switchable glazings for energy efficient windows (smart windows!). I will further discuss colossal metal—insulator switching recently discovered in M$_x$V$_2$O$_5$ bronze phases, platforms for photocatalysis that exploit the tunability of the band structure within these compounds, and the interplay between structure and chemical bonding for intercalation of Li and Mg-ions within V$_2$O$_5$ and the implications therein for novel battery architectures.

**Keywords:** smart windows, phase transformations, vanadium oxides

**References:**


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