Realizing a New Semiconductor for Power Electronic Applications

John T. Heron and Emmanouil Kioupakis, University of Michigan

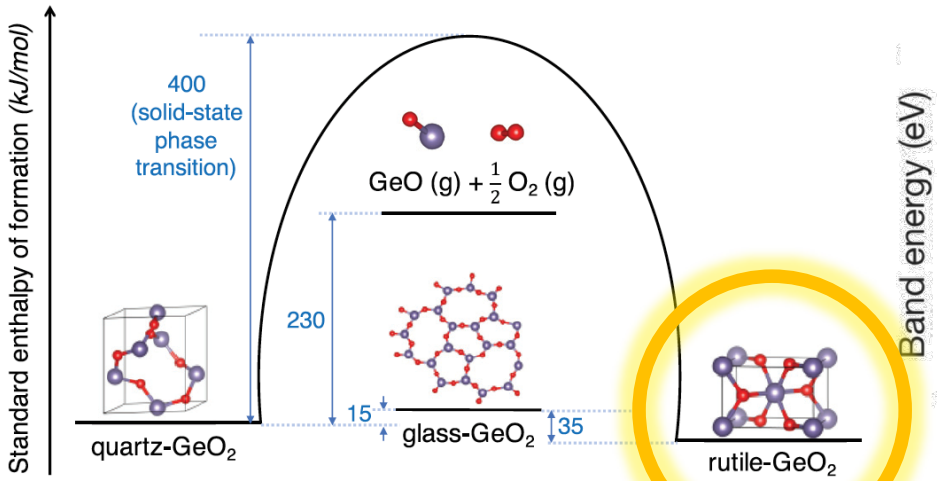
Materials discovery is more than calculating the properties that a material should have if the atoms were in desired positions. It is also key to get the atoms into those desired positions, to see what the properties really are, and thus realize the potential benefit of a new material. Making this happen takes a combination of ideas, capabilities, and execution—as the recent success by a team led by Assistant and Associate Professors from the University of Michigan illustrates.

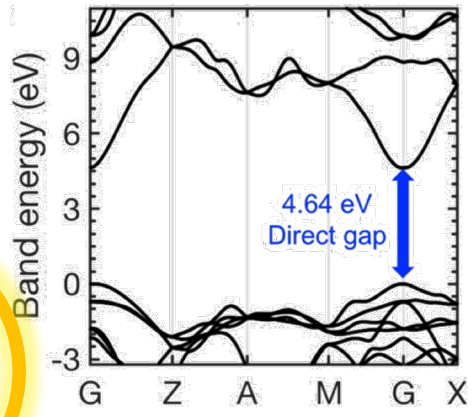
Theoretical work by the team established that rutile-GeO_2—with its ultra-high band gap (4.64 eV), high mobility, high heat conductivity, and desired dopability—could provide superior performance for power electronics. But can this material be made as a thin film? The common synthesis approach would rely on deposition of the constituting elements, but for GeO_2 growth is obstructed by a metastable glass phase and the volatile molecule GeO.

The team came to PARADIM and employed a recently established approach of "sub-oxide MBE"—using partially oxidized GeO instead of Ge—to realize the material in thin film form. Sieun Chae, the same graduate student who did the first-principles calculations, also grew the films. Her work has realized the first single crystal rutile-GeO_2 thin films.

S. Chae *et al.* Appl. Phys. Lett. 117, 072105 (2020).

A promising material is identified by theory





The promise:

high Band Gap ✔

high Mobility ✔

high Thermal Conductivity ✔

But can it be realized?