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Plastic Deformation and Metalworking of Inorganic Thermoelectric Materials

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The discovery of exceptional plasticity in a few semiconductors has challenged our conventional understanding of their mechanical properties, promising a shift in their processing and application paradigms. In this talk, I will report our recent progress on the understanding of the metal-like plasticity from different perspectives. (i) As to microstructures, we found an inherent quasi-bcc anionic sublattice hiding in the monoclinic structure of Ag_2S-based material, which gives rise to multiple slip systems that are identified by TEM analysis. We also deciphered the cross-layer slip and a martensitic transformation in InSe crystals, which are key to the plastic deformation. (ii) Guided by the energy principle of “easy to slip, hard to cleave”, we proposed a “deformability factor” and developed a high-throughput procedure, which screened out a series of ductile semiconductors, including high-performance thermoelectric materials. (iii) We enriched the deformability factor and well modeled the temperature-dependent plasticity. This model accurately captured the brittle-to-ductile transition temperature and picked several semiconductors that turn ductile below 500 K. We thus enabled metalworking in these materials, yielding high-quality, free-standing foils and high-performance thermoelectric devices.

References:

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