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Different Directions in Layered Electronic Materials

ABSTRACT: Layered and 2D materials are currently one of the most well-studied classes of solid-state compounds, due to the plethora of unique physical phenomena found in these materials coupled with advances in the characterization of structure and properties down to the single layer scale. Here, we will describe our recent work in the synthesis, properties, and applications of layered materials that simultaneously exhibit n-type conduction and p-type conduction depending on the direction that conduction occurs through the crystal. Electronic materials generally exhibit a single majority carrier type, either electrons or holes, uniformly along all directions of the crystal, which are then integrated together to create virtually all modern electronic devices. Recently, we discovered that NaSn_2As_2 , an exfoliatable 2D van der Waals material, simultaneously exhibits p-type conduction along the in-plane direction and n-type behavior along the cross-plane direction, a phenomenon we define as “goniopolarity”. We will establish the origin of this behavior, the chemical design principles for creating new goniopolar materials, and our recent successes in significantly expanding the number of known materials that exhibit this effect. Finally, we will show that goniopolar materials can significantly improve the efficiency of energy-harvesting technologies ranging from thermoelectrics and photocatalysis.

BIO:

Josh Goldberger received his B.S. in chemistry from The Ohio State University in 2001. He received his Ph.D. in chemistry from the University of California at Berkeley with Professor Peidong Yang in 2006, as an NSF graduate fellow. He then did his postdoctoral research with Professor Sam Stupp at Northwestern University as part of the Institute for BioNanotechnology in Medicine, as an NIH-NRSA postdoctoral fellow (2007-2010). He has received many awards, including an MRS Graduate Student Finalist Award in 2003, an IUPAC Prize for Young Chemists in 2007, a Camille Dreyfus Teacher-Scholar Award in 2015, a Lumley Interdisciplinary Research Award in 2019, and an ASC Mid-Career Excellence Award in 2020. He joined The Ohio State University Department of Chemistry and Biochemistry in 2010, and was promoted to Associate Professor in 2016, and Professor in 2020.