Solution-based Synthesis of 2D Nanoplates and Heterostructures for High Performance Electronics

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Solution dispersible inorganic nanostructures have emerged as interesting ink materials for lowtemperaturesolution processing of electronic thin films on various substrates including flexible substrates. The two-dimensional (2D) colloidal nanoplates, exhibiting few dangling bonds, represent an idealgeometry for the assembly of highly uniform continuous thin films with greatly reduced grain boundaries dictated by large-areaconformal plane− plane contact with atomically flat/clean interfaces. It can therefore lead to efficient charge transport acrossneighboring nanoplates and throughout the entire thin film to enable unprecedented electronic performance. Here, we demonstrate the synthesis of colloidal 2D nanoplates, as well as theheterostructures, of layered materials in solution as a new class of ink materials. We further demonstrate that these new ink materials can be assembled into high-performance electronic thin films. In particular, we show that Bi2Se3 and Bi2Te3 nanoplates can be synthesized with well-controlled thickness (6−15 nm) and lateral dimension (0.5−3 μm) and can be used for the assembly of highly uniform continuous thin films with a full surface coverage and an excellent room temperature carrier mobility >100 cm2·V−1·s−1, approaching that of chemical vapor deposition grown materials. These studies demonstrates the great promise in scaling up the synthesis of various 2D material structures in solution and demonstrates a general strategy of using 2D nanostructure s as a unique building block for future flexible electronics and optoelectronics.