Structural and Magnetic Characteristics of p-GaAs/MnAs Nanocluster Hybrids  
DAVID RENCH, PETER SCHIFFER, NITIN SAMARTH, Department of Physics and Materials Research Institute, The Pennsylvania State University, University Park, Pennsylvania 16802, USA — A possible route towards semiconductor spintronic devices involves the controlled synthesis of hybrid materials that combine ferromagnetic (FM) nanoclusters within a doped semiconductor host lattice. We use molecular beam epitaxy of (Ga,Mn,Be)As followed by in situ annealing to synthesize a systematic set of samples wherein FM nanoclusters are embedded in a p-GaAs matrix. High resolution transmission electron microscopy (HRTEM) and magnetometry demonstrate our ability to reproducibly synthesize two distinct classes of materials: (a) type I samples consisting of uniformly distributed, small clusters (\( \sim 6 \) nm); (b) type II samples consisting of a bimodal distribution of small (\( \sim 6 \) nm) and large (\( \sim 25 \) nm) clusters. HRTEM studies show that while the large clusters are clearly MnAs with NiAs structure, the smaller clusters are possibly zinc blende in structure but with a more complex composition. We analyze the magnetic behavior of these two classes of samples and show measurements of their transport properties. Supported by the ONR-MURI program.