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Anomalously large magnetoresistance in an antiferromagnet

Despina Louca[1]
[1]*Physics, University Of Virginia, Charlottesville, United States*
E-mail: louca@virginia.edu

Semiconducting electronics have been transformed in part due to progress in spin polarized transport. Central to modern day spintronics, contemporary magnetoresistive components are based on ferromagnetic multilayers. New directions in the search for the next generation of devices have led to promising materials such as room temperature antiferromagnets (1, 2). Tunneling devices built on antiferromagnetic nanostructures demonstrated the persistence of large and bistable magnetoresistance signals up to room temperature (3). It is still however rare that antiferromagnets show a large magnetoresistance under a magnetic field. An anomalously large positive magnetoresistance is a particularly uncommon material characteristic. Here, we show that of the I-Mn-V class of semiconductors, the tetragonal NaMnBi with TN ~ 340 K can exhibit extreme magnetoresistance in bulk form by controlling the defect concentration through quenching. With defects at the Na and Bi atomic sites, the electrical conductivity becomes metallic, the spin orientation changes from collinear along c to canted along (011) and a large magnetoresistance, greater than 10,000% at 2 K and 600 % at room temperature, is observed. In the absence of Bi defects, the magnetoresistance is severely suppressed. While both electron and hole carriers are likely present, the hybridization of the Mn and Bi orbitals may be key to the large magnetoresistance. Our system, NaMnBi, is a very good candidate for a new spintronic device based on antiferromagnetic semiconductors.

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