Current induced switching of an antiferromagnet

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The pioneer of the field of antiferromagnetism, Louis Neel, noted in his Nobel lecture that while abundant and interesting from the theoretical viewpoint, antiferromagnets did not seem to have any applications. Indeed, the alternating directions of magnetic moments on individual atoms and the resulting zero net magnetization make the moments in antiferromagnets hard to detect by common magnetic probes, and particularly hard to manipulate. Remarkably, in the same Nobel lecture, Neel pointed out the equivalence of antiferromagnets with ferromagnets in effects that are even in the magnetic moment. One such effect is anisotropic magnetoresistance (AMR). There have been several recent demonstrations of spintronic devices based on the anisotropic magnetoresistance (AMR) of antiferromagnetic materials (AF) [1, 2, 3,4]. In these devices either a coupled ferromagnet or cooling in an applied field is used to set the spin axis of the AF material, and only the reading is done electrically. Zelezny*et al* recently predicted a mechanism, by which an alternating field-like torque, termed a Neel order spin-orbit torque (NSOT), can be produced in crystals of specific symmetries [5] . In some AF materials these torques can coincide with the spin sub-lattices of the AF, and offer the tantalising prospect of current induced coherent rotation of the spin axis.

Here we report on the experimental demonstration of an all-electrically controlled antiferromagnetic memory device. In this device the NSOT is used to set the spin axis via a current pulse, and then the memory state is read electrically by measuring the AMR [6], and is also observed using photoemission electron microscopy (PEEM). All of this is performed at room temperature in the recently reported tetragonal AF CuMnAs [7].

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