Current Induced Effects with Antiferromagnets

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Current-induced excitations in ferromagnetic/non-magnetic (F/N) metal multilayers is now a major subfield of spintronics, of both scientific and technological interest. Unpolarized current sent through a ferromagnet (F1) usually emerges spin-polarized, and a spin-polarized current impinging on a second ferromagnet (F2) whose magnetic moment is not collinear with the spin-polarization of the current, can exert a torque on the moment of that second ferromagnet [1]. A large enough current density can cause this moment to precess (typically generating GHz radiation), or reverse its direction (switch). Since an antiferromagnet (AF) doesn't have a bulk net magnetization, one might assume that it would be unaffected by a large current density. However, MacDonald and co-workers recently predicted [2,3] that a large enough current density could affect an AF metal. Since their model calculations are for perfect metals, with completely ballistic transport, they give only qualitative guidance as to what might be seen with more realistic imperfect metals and the usually dominant diffusive transport. For such a case, experiments are needed. We recently showed [4], using a point contact to an F1/N/F2/AF multilayer, that a large current density sent through a ferromagnet (F1) could change the exchange bias coupling between a second ferromagnet (F2) and an antiferromagnet (AF). Urazhdin and Anthony confirmed this behavior in nanopillars [5]. In this talk, I will first discuss the results already published, and then describe new magnetoresistance (MR) measurements using a point contact to inject high current densities into AF/N/AF, F/AF/N/AF, and F/AF/N/AF/F multilayers. In this submitted work [6], we see no MRs in the first two cases. However, in the third case we see MRs that are 'inverted'—i.e. the resistance is largest when the F-layer moments are aligned parallel (P) to each other and smallest when they are aligned anti-parallel (AP). Since this behavior is opposite to the usual Giant MR (GMR) seen with simple F/N/F multilayers, we attribute our observed anti-ferromagnetic GMR--'AGMR'--to the AF-metals. Using the work of MacDonald et al. [2,3] as a guide, we suggest how such an AGMR might arise.

References

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