Disorder effects on tunneling magnetoresistance and coherent spin injection

M. Wimmer and K. Richter

Institute for Theoretical Physics, University of Regensburg, D-93040 Regensburg, Germany
Michael.Wimmer@physik.uni-regensburg.de

Since the seminal proposal of a spin transistor by Datta and Das electrical injection of spin polarized charge carriers from ferromagnetic metals into semiconductors has been subject of intensive research. Efficient spin injection has been found to be one of the fundamental challenges in the field of spintronics [1]. Most of the work on spin-dependent transport has been in the semiclassical diffusive regime of transport using Boltzmann theory [2]. Only recently there has been work in the coherent regime of transport pointing out that there can be effects without any semiclassical analog due to quantum interference effects.

However, the effects of disorder and scattering in the system have been mostly neglected in coherent spin-dependent transport calculations. Earlier work by G. Kirczenow [3] already points out the important influence of disorder at the ferromagnet-semiconductor interface. Experimental findings [4] also suggest that spin flip scattering might be of crucial importance in understanding the outcome of experiments.

We present numerical studies of tunneling magnetoresistance (TMR) and spin injection in the coherent regime of quantum transport in the Landauer formalism. The effect of spin conserving scattering and spin flip scattering in the materials is investigated and the results are compared to the semiclassical theory of transport.

References

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