LORENTZ MAGNETORESISTANCE OF THIN FILMS IN THE PRESENCE OF DOMAIN STRUCTURES

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Several recent experiments on the magnetoresistance in thin films with a well-characterized domain structure were widely perceived as evidence of an intrinsic domain-wall resistance.[1] In particular, iron film microstructures show an enhanced conductivity of the domain state compared with the homogenously magnetized state which cannot be explained by standard corrections for anisotropic magnetoresistance and Lorentz magnetoresistance.[2] This led to some speculation on a negative intrinsic domain-wall resistance. However, ballistic Lorentz magnetoresistance, where the mean free path of the electrons is of the same order than the film thickness and the domain size, offers an alternative interpretation of experimental results [2]. We developed and employed a numerical model of ballistic electronic transport in thin films with diffuse surface scattering in the presence of a magnetic domain structure[3]. The conductance is obtained from the diffusive mean square displacement of the conductance electrons. Lorentz magnetoresistance effects in several domain structures are simulated and compared to corresponding experiments. We conclude that there is no need to assume an intrinsic domain wall resistance in pure iron [2] and cobalt [4] films in order to explain experimental results. More generally, simulation results indicate that additional Lorentz magnetoresistance related to the domain-structure scale is best understood in terms of three separate effects, which all scale with the Lorentz magnetoresistance of the homogenously magnetized film.

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