117 Electrical resistivity induced by grain boundary scattering and localization due to disorder, in nanoscale metalic structures by means of a quantum formalism.

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We calculate the electrical resistivity of a metallic sample, under the combined effects of electron scattering by distributed impurities, a random distribution of grain boundaries, and a rough surface limiting the film, by means of a quantum mechanical procedure based upon the Kubo formalism with Green's function built from the Kronig-Penney(KP) potential and grain boundaries represented by a one-dimensional periodic array of Dirac delta function potentials. We analyze with our theory and with the Mayadas and Shatzkes semi-clasical theory (MS)[2] the resistivity of samples S1, S2, S7 and S8 reported in [1].

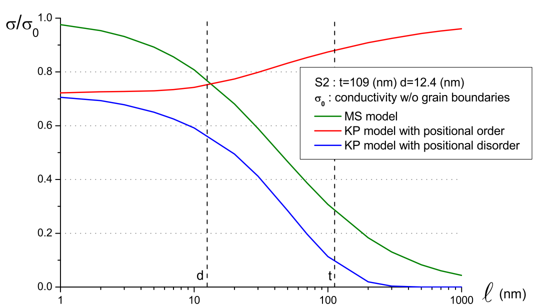

Fig. 1 *Dependence of the conductivity ratio σ/σ_0 with the bulk mean free path according to the classical MS and the proposed quantum theory based on the KP model with and without positional disorder on the grain boundaries.*

We find the resistivity increase is attributed to a decrease in the number of states at the Fermi sphere that are allowed bands of the KP potential arising from grain boundaries, and when the films are made out of grains whose diameter d is significantly smaller than the electronic mean free path ℓ in the bulk, then a large fraction of the resistivity increase arises from localization[3] induced by electron grain boundary scattering from an array of disordered grains characterized by a dimensionless dispersion s.

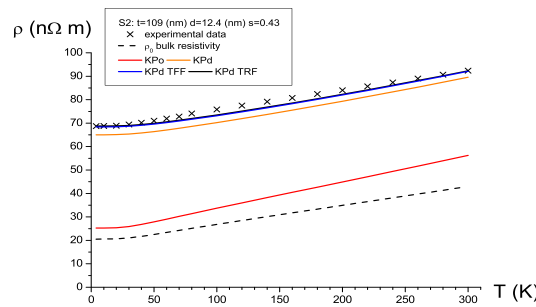

Fig. 2 *Temperature dependence of the resistivity of sample S2 - of thickness t - according to the quantum theory, with separated effects of the KP potential, with and without disorder (KPo and KPd resp.), in a thin flat and rough film (KPd-TFF and KPd-TRF resp.).*

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