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The quest for imperfection

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The stoichiometric compounds Ag_2S, Ag_2Se and Ag_2Te are superionic conductors at higher temperature. Below 400 K, ion migration is effectively frozen and the compounds are non-magnetic semiconductors that exhibit no appreciable magnetoresistance. We showed that slightly altering the stoichiometry can lead to a marked increase in the magnetic response; up to 200 % at room temperature and in a magnetic field of 5.5T in $Ag_{2+\delta}Se$ and $Ag_{2+\delta}Te$ (δ about 10^{-4}) reaching a maximum of about 350 % at low temperature. But more importantly, the response can be almost linear in magnetic field even at low magnetic fields. Not only do these silver chalcogenides show linear magnetoresistance, this response also is still unsaturated up to 55 T showing no signs of saturation. M. Parish and P. Littlewood identified inhomogeneities as a key factor. Their theoretical model has initiated a project on artificially created structures in semiconductors to mimic transport in real materials with inhomogeneities. We processed a number of different geometric realizations in collaboration with L. Cohen's group at Imperial College, London, on their InSb epilayers on GaAs (001). However, the films themselves have a very large and almost linear and non-saturating (up to applied fields of 13 T) magnetoresistance intrinsically which made the interpretation of the results somewhat difficult. We then went back to the origin of this intrinsic magnetoresistance by comparing, at room temperature, undoped InSb epilayers grown on GaAs(001) by molecular-beam epitaxy with varying thickness from 100 to 2000nm. The question is whether these films and the silver chalcogenides share a similar physical origin for their magnetoresistance. Experiments to very high fields in InSb films are on the way.