



# Magnetization-driven Metal-insulator Transition in Strongly Disordered Ge:Mn Magnetic Semiconductors

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Fabricated by ion implantation Mn-doped Ge enters the insulating state below 20–30 K at zero field and under high applied magnetic field at higher temperatures (see Fig. 1a). The transition to the low temperature insulating state is accompanied by the transition into a highly disordered ferromagnetic phase. Field-driven transition into the insulating state is the origin of a huge positive magnetoresistance of thousands of percent. The extraordinary Hall effect is suppressed in both the low temperature and the high-field insulating states. All magnetoresistance isotherms in the metallic-like temperature range can be scaled by a universal function with a single scaling field parameter that depends on temperature and fabrication (see Fig.1b). The scaling is general and is applicable to samples prepared by different methods and having different disordered microscopic structures. The same scaling field parameter characterizes also the magnetic field dependence of EHE. We argue that the transition to the insulating state is related to a strongly inhomogeneous distribution of magnetic moments that leads to localization of conducting holes. Thus, it is the strong magnetic disorder which is responsible for the colossal magnetoresistance and other unusual properties of Ge:Mn alloys. Universality of the scaling is remarkable and should serve the test tool for microscopic theories of magnetotransport in magnetic semiconductors.

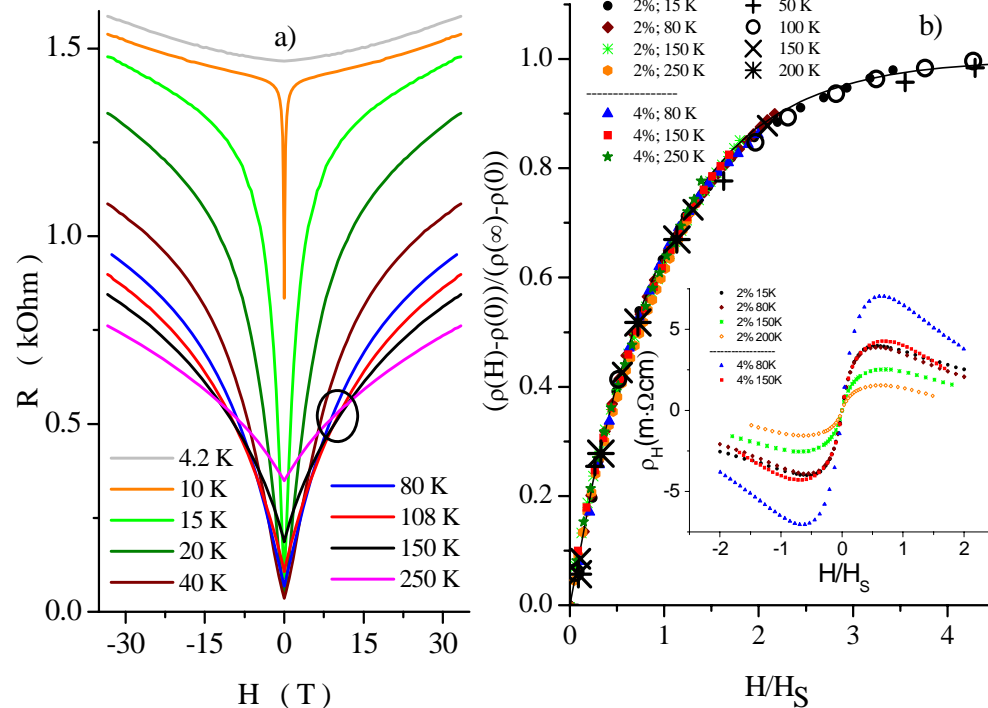


FIG. 1. a) Resistance of a Ge:Mn sample as a function of applied magnetic field at different temperatures. The crossover region between the metallic-like and insulating phases is indicated by the circle. b) Scaled magnetoresistance of the 2% and 4% Mn-implanted Ge samples (filled symbols) and the MBE grown samples (symbols +, o, x, \*) measured at different temperatures.  $H_s$  is a scaling parameter. Inset: Scaling of the EHE resistivity component of 2% and 4% samples.

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