Magnetic and electric properties of $FeGe_2$

Byong Sun Chun[1,*], Chanyong Hwang[1]
Center for Nanometrology, KRISS

Figure shows the magnetization versus temperature (M-T) curves both an in-plane and an out-of-plane configuration at temperatures ranging from 30 to 320 K. In here, magnetization is measured under the external magnetic field of 4 kOe. At above room temperature, $FeGe_2$ film does not shows any magnetic moment then at around 275 K magnetic moment start to arise. $FeGe_2$ has different magnetic structure along the c-axis and a-axis. $FeGe_2$ has ferromagnetic alignment of Fe atoms along the tetragonal c-axis while antiferromagnetic spiral structure along the a-axis and results in formation of two magnetic sublattices. Figure also shows the temperature dependent resistivity of the $FeGe_2$ film under the external magnetic field. At lower temperature region (30–230 K) the resistivity shows a gradual increase with temperature, which shows a positive gradient of 0.125 μΩcm/K. At the temperature from 230 K to 275 K, the resistivity of the FeGe begins to sharply increase with a positive gradient of 7.4 μΩcm/K. However, beyond 275 K it suddenly decreases. The nature of decreasing and increasing resistivity with temperature indicates nonmetallic and metallic behavior, respectively. Therefore, the resistivity measurement of the $FeGe_2$ reveals a semiconductor-metal transition. The presence of a local maximum in the resistivity versus temperature (metal-insulator type transition temperature) in ferromagnetic metals and paramagnetic semiconductors is closed to the Curie temperature (T_C). In this, ferromagnetic-paramagnetic transition observed around 275 K (T_C). As shown in this figure ferromagnetic-paramagnetic transition have a significant effect on the resistivity. The development of ferromagnetism results in increment of electrical conductivity. Under the external magnetic field with lowering the temperature, the degree of ordering increases and this leads to growth of the ferromagnetic phase but shrinkage of semiconductor phase results in metal-insulator type transition. In $FeGe_2$, initially, relatively small metallic ferromagnetic domains (Fe) are embedded in relatively large semiconducting paramagnetic domains (Ge), when the temperature is decrease with increasing external magnetic field, the ferromagnetic domains are growing, and results the type of conductivity change from semiconducting to metallic.

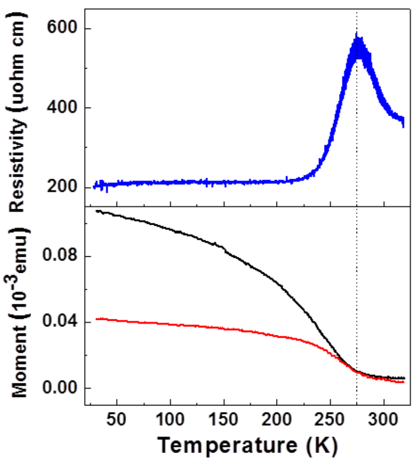

Fig. 1. Magnetic and electric properties of $FeGe_2$