Helimagnetic Order in the Cubic FeGe Nanowires

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Chiral magnetic orders such as helical spin textutres and skyrmions have attracted extensive attention because of their potential applications in magnetic data strorage and spintronic devices. The helical ground state comes from the combination of the ferromagnetic exchange and Dzyaloshinskii-Moriya interaction (DMI). The representative materials with such properties are non-centrosymmetric crystals with magnetic order such as Si- and Ge-based alloys with the B20 crystal symmetry (MnSi, $Fe_{1-x}Co_xSi$, FeGe, and MnGe). Especially, FeGe bulk crystal exhibits a relatively high helical transition temperature (~280 K) and long helix period (~ 70 nm). It is very interesting to see the influence of crystal size comparable to the helix period on the helimagnetic order. Here we study the helimagnetic order in the cubic FeGe nanowires with varying the diameter of nanowires.

The FeGe nanowires are synthesized by vapor-solid (VS) mechanism with $GeCl_4$ gas and FeI_2 powders in chemical vapor deposition (CVD) system. We investigate the temperature dependence of the magnetoresistance in the cubic FeGe nanowires with applying external magnetic fields longitudinal to the growth axis of the nanowire ($[001]_{FeGe}$ direction). We observe a distinct response of magnetoresistance as a function of magnetic field, which indicates the presence of helimagnetism in the FeGe nanowire. We find that the helimagnetic and/or concial state in the FeGe nanowire is stable up to room temperature and maintained to higher fields in comparison with the bulk FeGe. At near room temperature (240 - 280 K), we observe that the resistance of the FeGe nanowire fluctuates in a narrow temperature range which is presumed as a consequence of the skyrmion state. This temperature range has been shifted toward a higher temperature as the diameter of the nanowires decreases, demonstrating the effect of low-dimensional confinement on the chiral magnetic orders.