# Observation of helimagnetism in FeGe Nanowires

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We report on the magneto-transport of single crystalline iron monogermanide (FeGe) nanowires (NWs) in order to explore the existence of hellimagnetism in nano-scale materials. Transition metal silicides and germanides are reported to have chiral cubic helimagnetism resulted from broken inversion symmetry and the Dzyaloshinskii-Moriya (DM) interaction. In particular, FeGe is a fascinating material because it is known to have a helical spin order with a relatively long period (700 Å) and high Neel temperature (~280 K).[1] Meanwhile, nanowires featured by one-dimensional confinement effect as well as anisotropic structure help to realize helimagnetism in FeGe as a new approach.

Single crystalline FeGe NWs were grown on a sapphire (0001) substrate without any catalyst by the CVD process. The diameter of FeGe NWs decreases from 200nm to 40 nm with $H_2$ carrier gas ratio, Accordingly, we are able to control composition and structure of the nanowire. As decreasing diameter of FeGe NW, the crystal structure of the nanowire changed from hexagonal to monoclinic structure. The structural characterization reveals that as-grown FeGe NWs of which diameter is 70 nm is monoclinic phase.

Signature of the helimagnetism in the FeGe NWs can be detected by measuring the field dependent longitudinal magnetoresistance (MR). The magnetic transition from the helimagnetic to the conical helimagnetic state occurs at much higher fields ($H_c$) than that of the bulk FeGe.[2] A significant magnetoresistance of the NWs is still observed at near room temperature indicating the helimagnetism in FeGe NWs is sustained until the temperature. It may be due to the one dimensional confinement effect that plays a major role to stabilize the helimagnetic state in the FeGe NWs.

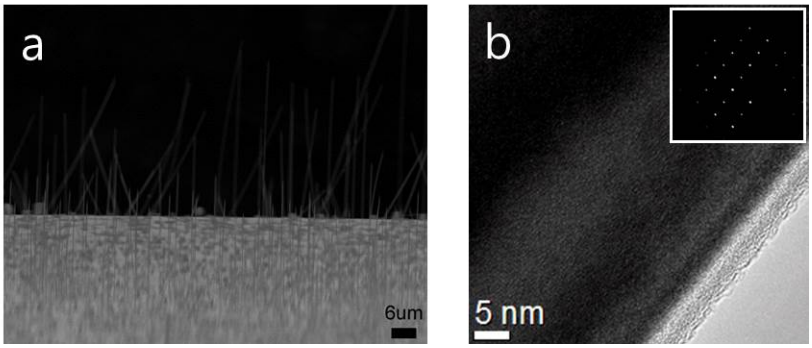


**Fig 1.** (a) SEM and (b) TEM images of FeGe nanowires synthesized in the study

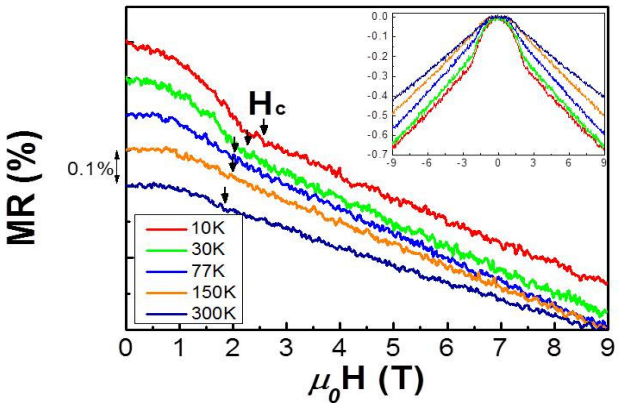


**Fig 2.** The temperature dependence of magnetoresistance of FeGe nanowires showing the magnetic transitions (Hc) from the helimagnetic to the conical helimagnetic state.

## Reference

[1] Jeremy M. Higgins, Ruihua Ding , John P. DeGrave and Song Jin, Nano Lett., 2010, 10 (5), pp 1605–1610 (2010)

[2] Near room-temperature formation of a skyrmion crystal in thin-films of the helimagnet FeGe, X. Z. Yu, N. Kanazawa, Y. Onose, K. Kimoto, W. Z. Zhang, S. Ishiwata,Y. Matsui & Y. Tokura, Nature Materials 10, 106–109 (2011)