Electronic Supplementary Information (ESI)

Controllable rotational inversion in nanostructures with dual chirality

Lu Dai,[a,e] Ka-Di Zhu,[b] Wenzhong Shen,[b] Xiaojiang Huang,[c] Li Zhang,*[d] and Alain Goriely[e]*

[a]School of Mathematics and Physics, Suzhou University of Science and Technology,

Suzhou 215009, China

[b]Department of Physics and Astronomy, Shanghai Jiao Tong University, 800 Dongchuan Road. Minhang

District, Shanghai 200240, China.

[c]College of Science, Donghua University,

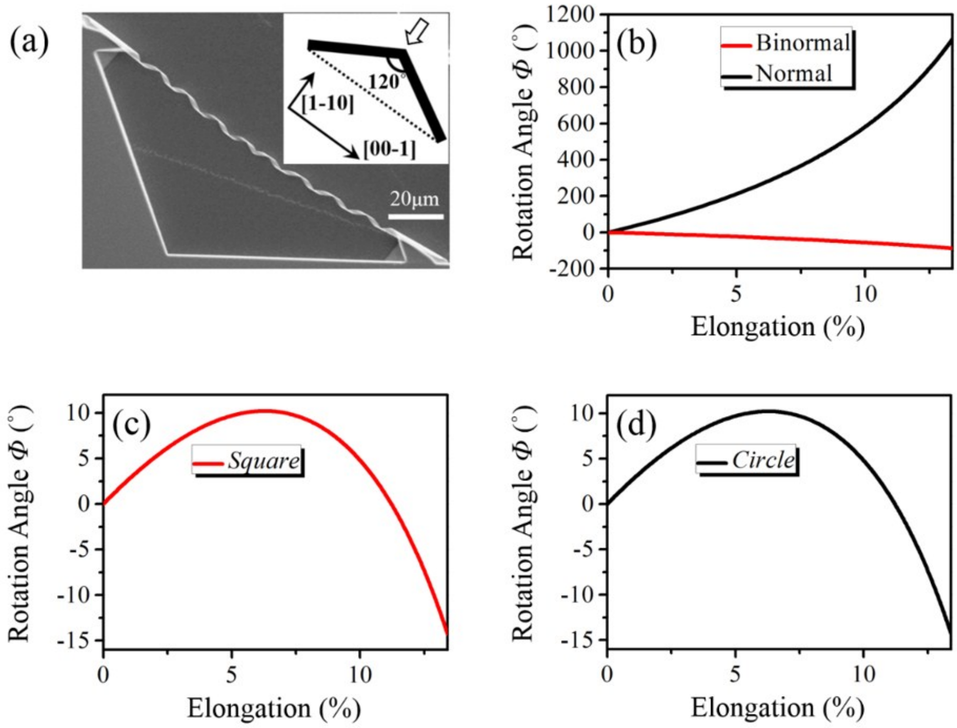
Shanghai 201620, China

[d]Department of Mechanical and Automation Engineering, The Chinese University of Hong Kong, Shatin NT,

Hong Kong SAR, China

[e]Mathematical Institute, University of Oxford, Oxford OX2 6GG, United Kingdom

Supplementary-Figure S1



Supplementary-Figure S1. (a) SEM image of a binormal SiGe/Si/Cr dual-chirality helical nanohelix formed by a symmetric V-shaped mesa with both ends fixed to the Si(110) substrate. The inset shows the mesa design and the rolling direction of the helix as indicated by a hollow arrow. Rotation angle of perversion versus axial elongation (b) for the fabricated binormal nanohelix and a normal one with the same parameters, as well as for the transversely isotropy dual-chirality nanohelices with (c) square and (d) circle cross-sections.

Fig. S1(a) shows that a binormal dual-chirality nanohelix on Si(110) substrate is fabricated from the symmetric V-shaped SiGe/Si/Cr nanobelt with width w=1.57μm and the layer thickness t_{SiGe}=8nm, t_{Si}=10nm, t_{Cr}=13nm, which leads to a left- and right-handed arm having the same geometry parameters. The binormal nanohelix with dual chirality has radius a_0=1.4μm, pitch b_0=13.5μm and N_0=4. The insets present the V-shaped mesa designs of 120°, as well as the rolling direction of the helix as indicated with a white arrow. In the following calculation, we use the parameters of this fabricated SiGe/Si/Cr nanohelix, including the area of the cross-section, the radius, the pitch, the number of turns, and the material parameters.

Fig. S1(b) presents the rotation angle of perversion versus the axial elongation for the fabricated binormal and normal SiGe/Si/Cr nanohelix with the red curve and black one, respectively. The modeling results are deduced from (1)-(6) with the geometry parameters as well as the material parameters of E_{SiGe}=161.2GPa, v_{SiGe}=0.27[1] E_{Si}=168.9GPa, v_{Si}=0.36,[2,3] E_{Cr}=377GPa, v_{Cr}=0.31.[4] The binormal nanohelix and the normal one unwinds 87˚ and winds 1070˚, respectively, when they are extended to the straight belts by axil load.

Fig. S1(c) presents the rotation angle Φ of perversion versus the axial elongation for a transversely isotropic dual-chirality nanohelix with square cross-section, derived from (1)-(7). In the loading process, the dual-chirality nanohelix with square cross-section exhibits the rotational inversion: it first overwinds to 10.2˚, when the elongation increases to 6.3%; then unwinds to 14.7˚, when it is extended to the straight belt by axil load. Fig. S1(d) shows that a fabricated SiGe/Si/Cr nanohelix circular cross section also exhibits the rotational inversion behavior.

REFERENCES

1. L. Zhang, E. Ruh, D. Grutzmacher, L. X. Dong, D. J. Bell, B. J. Nelson, C. Schonenberger, *Nano Lett.*, 2006, **6**, 1311-1317.

2. X. L. Li, *J. Phys. D: Appl. Phys.*, 2008, **41**, 193001(1-12).

3. J. J. Wortman, R. A. Evans, *J. Appl. Phys.*, 1965, **36**, 153-156.

4. S. V. Golod, V. Ya. Prinz, P. Wägli, L. Zhang, O. Kirfel, E. Deckhardt, F. Glaus, C. David, D. Grützmacher, *Appl. Phys. Lett.*, 2004, **84**, 3391-3393.