Regioselective magnetization enabled chiral semiconducting heteronanorods

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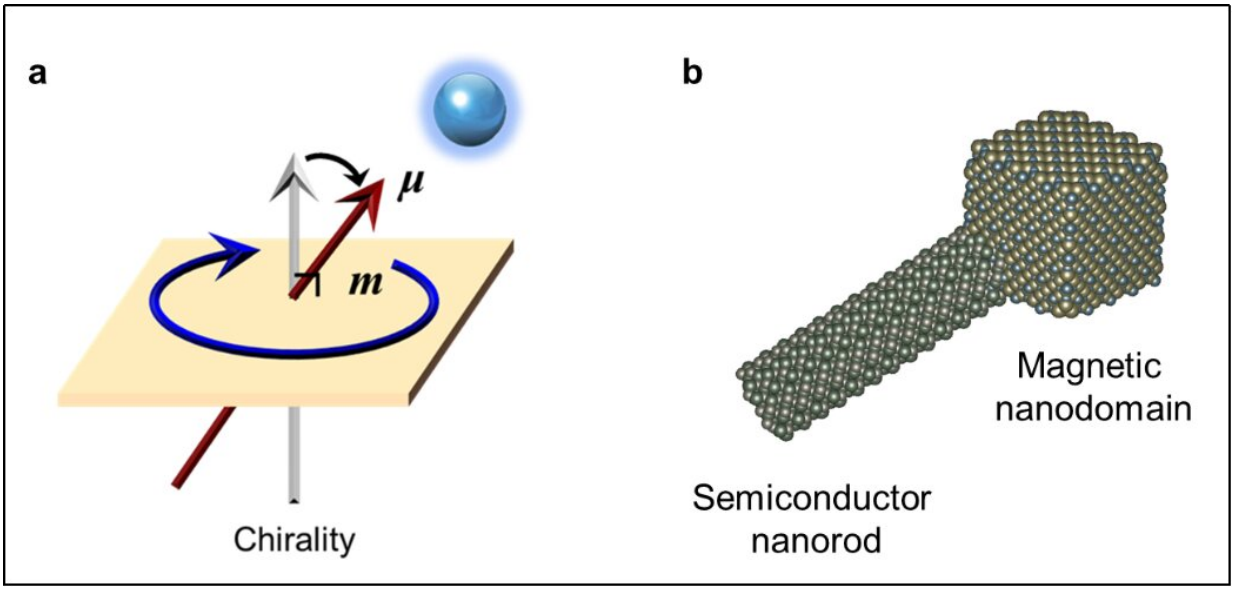

a, Schematic illustration of magnetically induced chiroptical activity. b, Model of materialized magnetite nanodomain at one apex of ZnxCd1-xS semiconductor nanorod. Credit: ZHUANG et al.

A USTC team led by Prof. Shu-Hong Yu (USTC), collaborating with Prof. Zhiyong Tang (National Center for Nanoscience and Technology, China) and Prof. Edward H. Sargent (University of Toronto), has shed new light on the topic of chiral inorganic nanomaterials. Researchers demonstrated a regioselective magnetization strategy, achieving a library of semiconducting heteronanorods with chiroptical activities.

The research article, titled "Regioselective magnetization in semiconducting nanorods," was published in *Nature Nanotechnology* on Jan 20th.

Chirality—the property of an object non-superimposable with its mirror image—is of widespread interest in physics, chemistry and biology. Chiroptical activity in materials can be tuned by electric and magnetic transition dipoles. To date, the chemical construction of chiral nanomaterials has been achieved through the introduction of chiral molecules and geometrically helical structures to provide modulation, but these methods limit their environmental instability—chirality disappears under illumination, heating or in a harsh chemical environment. Poor conductivity can result, since charge transfer processes toward surface reactants and electrodes are impeded. These limitations hamper further practical applications of chiral materials in various areas.

Designing magneto-optical nanomaterials offers an opportunity to modulate the interactions between electric and magnetic dipoles via the local magnetic field, underlining another promising approach to enable chirality. To materialize such chiroptically active media, the growth of magnetic units has to be achieved at targeted locations of parent nanomaterials. One-dimensional chalcogenide semiconductor nanorods stand out as compelling candidates to serve as the parent materials due to their high geometric anisotropy, large electric dipole moment along nanorods, ease of composition and size modulations, as well as promising applications in catalysis, photonics, and electronics. However, the epitaxial growth between host and motif materials of large lattice and chemical mismatches, let alone the regioselective growth, present technical challenges.

Taking up the challenge, researchers reported a double-buffer-layer engineering strategy to achieve the selective growth of magnetic

materials at specific locations on a wide variety of semiconducting nanorods. The authors sequentially integrated Ag_2S and Au intermediate layers at one apex of each nanorod to catalyze the site-specific growth of Fe_3O_4 nanodomains. Due to the location-specific magnetic field, the resulting magnetized heteronanorods exhibit deflected electric dipole moment. In this way, the non-zero interaction between electric and magnetic transition dipoles induces chiroptical activity in the absence of chiral ligands, helical structures and chiral lattices—a phenomenon not observed outside of modulation. The regioselective magnetization strategy opens a new avenue to designing optically active nanomaterials for chirality and spintronics.

More information: Tao-Tao Zhuang et al, Regioselective magnetization in semiconducting nanorods, *Nature Nanotechnology* (2020). DOI: 10.1038/s41565-019-0606-8

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