

## Nano- to micro-sized carbon helical wires

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### Abstract:

*Nano- to micro-sized carbon helical wires have been fabricated from the catalytic pyrolysis of acetylene in chemical vapor deposition (CVD). The synthesized helical wires can be categorized into twisted rope-like close packings. The mirror-imaged growth and one-to-one corresponding chirality changes in the paired chiral carbon helices have provided a clear evidence to support the model of a rotating catalyst-particle during the helical growth. Left- and right-handed carbon helices extrude simultaneously from two hemispheres of a rotating catalytic copper-particle, resembling the distinct vortical handedness of cyclones or oceanic hydrodynamic flows in the northern/southern hemisphere of the Earth. Electron microscopic image reveals that CHWs possess a graphite-short-range-ordering (GSRO) structure, which is consistent with Raman scattering measurement. The carbon helical wires can potentially be applied as nanoscaled device elements, e.g. inductive circuits, field emitters for flat panel displays, generators of magnetic beams, effective fillers in electromagnetic shielding materials, etc.*

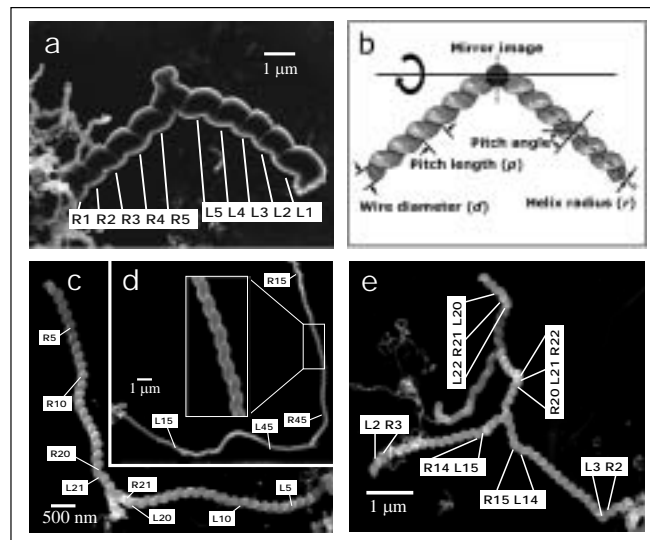


Figure (a) SEM morphology of the synthesized carbon helical wires (CHWs). The right (R)- and left (L)- handed carbon helices have a mirror-reflection symmetry with a copper particle embedded in the joint area as an enantiomeric center. The labeling numbers are counted as a growing temporal sequence. (b) Schematic illustration for a rotating catalyst-particle model. Left- and right-handed helices extrude simultaneously from two hemispheres of a rotating catalyst-particle. Pitch length, wire diameter, helix radius, and pitch angle are defined. (cd) SEM morphologies of twisted rope-like CHWs with total pitch number of 46 and 106, respectively. See a chirality change at 20→21 in (c). The enlarged image in d is magnified by three times. (e) The mirror-imaged growth and one-to-one corresponding chirality changes (pitch numbers: 2→3, 14→15, and 20→21→22) in the CHWs. The lower pair of CHWs (labeled with 117) grew first, followed by the upper pair (labeled with 1826). Vermicular fiber-like segments in the final stage of synthesis were caused by the translation, without rotation, of the copper particle due to lowering temperature in the end of experiment.