Automatic Nanorobotic Characterization of Anomolously Rolled-up SiGe/Si Helical Nanobelts Through Vision-based Force Measurement

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Abstract: We have described and demonstrated a model based tracking system suitable for use in a Scanning Electron Microscope under a variety of conditions. This system has demonstrated an ability to work with noisy images, sub-pixel resolution at a variety of magnifications and the ability to track moving targets at realtime (~10 fps) framerates. With this vision tracking system, the mechanical properties of anomalous, rolled-up, small pitch SiGe/Si/Cr helical nanobelts are experimentally investigated using nanorobotic manipulation in 3-D free space. Their ultra-high flexibility (0.003 N/m) and exceptionally wide linear range (91% elongation from their unextended state) are far superior to either bottom-up synthesized nanocoils or top-down rolled-up ones. Besides these features, the high degree of precision with which their diameter, chirality, helicity angle, and pitch can be controlled indicate their high suitability for batch fabrication and for application as elastic elements in ultra-sensitive, large-range force/mass sensors for chemical sensing, bio-sensing, property characterization of nanomaterials, and elastic elements of nanoelectromechanicl systems (NEMS).