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A New Class of Submolecular Switches Based on Conformational Changes

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ABSTRACT

Dibenzocyclooctadiene (DBCOD) that consists of a flexible eight-membered ring fused into two rigid phenyl rings has been intensively investigated by us. We have demonstrated that a polymer system that contains a small amount of DBCODs without any process optimization exhibits an anomalous giant thermal contraction. The best thermal contraction observed to-date for the DBCOD-based polymer system is about 12 times greater than the second best reported system. Spectroscopic analysis in corroboration with theoretical calculations indicate that the origin of this colossal thermal contraction is the conformational change of DBCOD from the ground state, the twist-boat conformer, to the local minimum, the chair conformer.

A composite in which carbon nanotubes (CNTs) are covalently linked to a DBCOD-containing polymer exhibits 24 times higher thermal contraction stress than the pure polymer counterpart owing to the excellent NIR infrared absorbing ability of CNTs. We have also fabricated a bilayer system that consists of aligned CNTs as a top layer and DBCOD-containing polymer as a bottom layer. Power-efficient directional bending the twisting has been achieved and thus enabling energy efficient soft robotics. More recently, we have prepared a linear polymer with DBCODs on the polymer backbone. Not only does it exhibits impressive negative thermal expansion of -700 ppm/K from 80 ° C to 200 ° C but also the negative thermal expansion coefficient can be adjusted by the amount of DBCODs incorporated into the polymer. This phenomenon can be exploited for creating electronic packaging polymers with ultra-low thermal expansion to significantly improve device reliability. The DBCOD conformational change in response to ambient temperature fluctuations can be exploited for heliotropism and thermal energy harvesting etc.

BIO:

Jennifer Lu is one of the first three faculty members who established the Materials Science and Engineering program at UC Merced -- California's newest research university. Prior to joining UC Merced, she acquired ten years industry experience at IBM and Agilent Technologies. She holds over 20 patents related to device fabrication, and consistently publishes her work in high impact factor journals. She was a recipient of the DARPA Young Investigator award. She was an invited participant in the Frontiers of Science and Engineering workshop co-sponsored by NAE, NAS, and the Brazilian Academy of Sciences. She is Director of the Merced NAnomaterials Center for Energy and Sensing (MACES) sponsored by NASA.