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Abstract

Carbon-Origami: Controlling 3D Shapes and Microstructure †

Marc Madou

UC, Irvine, CA 92671, USA; mmadou@uci.edu

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Abstract: Over the last two decades, we have gained more and more insight into how to convert patterned polymer precursors into predicable 3D carbon shapes using pyrolysis/carbonization (carbon origami are a more recent example). Over the last four years, we have started gaining control over the internal carbon microstructure and its functionality. The key to the latter is a precise control of the polymer precursor chains and the exact polymer atomic composition of the polymer before and during pyrolysis. Contradicting Rosalind Franklin, we have found that it is possible to graphitize even non-graphitizing carbons, simply by applying mechanical stresses to align the polymer precursor chains and stabilizing them in position before pyrolysis. Perhaps the most surprising outcome of this work is the demonstration of the conversion of PAN fibers through pyrolysis into turbostratic graphene-suspended wires with diameters as small as 2 nanometers. The suspended graphene bridges have a conductivity similar to that of multiwall carbon nanotubes (MWCNTs), a Young's modulus of >400 GPa, and electrochemically the material behaves similarly to graphene doped with nitrogen. The latter material represents a very electroactive electrode ideally suited for energy and sensing applications. The current fabrication process for graphene doped with nitrogen is lengthy and complicated; ours is a one-step, simple process that is easily scalable.

Keywords: carbon; origami; graphene; Carbon-MEMS

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