Towards Nanodevice Fabrication: Joining and Connecting Single-Walled Carbon Nanotubes

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Using state-of-the-art electron microscopy, we demonstrate that high-energy electron irradiation at elevated temperatures (700–800°C) results in the molecular merging of adjacent single-walled carbon nanotubes (SWNTs) via a zipper-like mechanism. In order to elucidate this coalescence process, we perform tight-binding molecular dynamics (TBMD) calculations at 1000°C. These simulations indicate that only a few vacancies (generated experimentally by knock-on effects on the tube surfaces) between two adjacent tubes of the same chirality trigger tube coalescence via a zipper-like mechanism. We further demonstrate theoretically that two crossing tubes containing a limited number of vacancies (dangling bonds) connect molecularly at 1000°C, resulting in the creation of an “X” molecular nanotube junction. Along this line, we propose a method for creating novel nanotube “X” and “Y” junctions, which could be developed in the fabrication of nanotube heterojunctions, robust composites, contacts, nanocircuits and strong 3D composites using SWNTs.