Low-energy electron beam does not damage single walled carbon nanotubes

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Scanning electron microscopy (SEM), which offers high resolution of a few nm and large scanning area, is a widely used tool for examining nanomaterials including single walled carbon nanotubes (SWNTs). Imaging nanotubes with SEM requires exposure of nanotubes to low energy electron beam (e-beam). Earlier studies, performed mostly by Suzuki et al., concluded that the low energy e-beam used in SEM damaged carbon nanotubes, resulting in increased disorder mode (D-mode) in Raman spectra of SWNTs. They also claimed that annealing the damaged SWNTs at high temperature helped reorientation of crystal structure and thus the removal of D-mode. Since then, a large number of researchers in the nanotube community has cited the studies and accepted their conclusion for more than 10 years without further verification. In this work we present evidences that the increased D-mode of SWNTs after SEM imaging is caused not by actual damage made to the nanotubes, but rather by native amorphous carbon attached onto SWNTs during their synthesis. Our study suggests that the notion that has long been accepted by the community might need to reconsidered, and thus help unambiguously study nanoscale phenomena in SWNTs.