Study of an Alternative Process for Oxidizing Vapor Grown Carbon Nanofibers using Electron Beam Accelerators

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Abstract:

The use of a high-energy electron beam was explored in this study as an alternative technique for oxidizing carbon nanofiber surfaces. The radiation exposures were carried out at three different electron beam facilities with beam energies of 1.5, 3.0 and 4.5 MeV and radiation doses ranging from 1000 to 3500 kGy. XPS analysis showed that oxygen was readily incorporated on the surface: the ratio O 1s/C 1s may increase approximately by a factor of 4 when the carbon nanofibers were irradiated at 3500 kGy. The oxidized nanofibers exhibited better dispersion in a water/methanol solution (50% v/v) than as-received nanofibers. Raman spectroscopy revealed that the ID/IG ratios for mostly all samples were statistically unchanged because the damage on the nanofiber surface was highly localized and did not lead to modifications on the bulk carbon nanofiber structure. The samples irradiated at higher dose rate exhibited significantly higher ID/IG ratios. The radiation process introduced defects on the graphene layers leading to decrease the decomposition onset temperatures up to 56 °C lower than the non-irradiated samples. The central challenge with carbonanofibers is developing controlled and scalable methods for modifying their surface for optimum dispersion in polymer and composite systems to form strong adhesive bonds. Overall the results were repeatable across all facilities, illustrating the robustness of the process.

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