Excimer Laser Treatment of Carbon Nanotubes*

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Abstract: Raman spectroscopy and spectral responsivity measurements are performed to investigate the alteration of sample purity and morphology, caused by varying pulse parameters for laser treatment of bulk carbon nanotubes using a 248 nm excimer laser.
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In this work we examine laser treatment of unaligned bulk nanotube samples as a potentially simple and fast purification method. The effects of laser treatment by a 248 nm excimer laser at various pulse lengths and time of exposure are evaluated to gain control and selectivity for the removal of carbon impurities from nanotube samples. Raman spectroscopy is employed to monitor changes in the purity of nanotube samples, while the topology and morphology are monitored by atomic force microscopy (AFM) and scanning electron microscopy (SEM). Bulk nanotubes are applied to a pyroelectric detector in order to measure their spectral responsivity [1], and measured as a function of laser fluence level. We correlate Raman, AFM and responsivity data of the nanotube samples for various laser irradiation treatments to quantify the effect of the laser fluence on the sample.

A previous report describing laser treatment at 514.5 nm [2] laser has shown a decrease in carbon impurities in bulk nanotube samples; however, this study employed a laser with a small spot size and a beam with a Gaussian distribution of energy, resulting in nonuniform irradiation across the sample. The 248 nm laser employed in this study uses a homogenizer, therefore ensuring a uniform energy beam profile, and furthermore, a beam size of ~1 cm^2 enables large areas of uniform irradiation to occur. Resonance of the incident photons at 248 nm with the π-plasmon may facilitate purification and a narrowing of the diameter distribution in nanotube samples.

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Figure 1 shows a SEM image of a bulk single-walled carbon nanotube film before and after laser treatment by a 248 nm laser. These images reveal a change in the morphology of the nanotubes and qualitatively indicate an increase in the porosity of the film after laser treatment. Further characterization of the effects of laser treatment on the purity and morphology are presented.

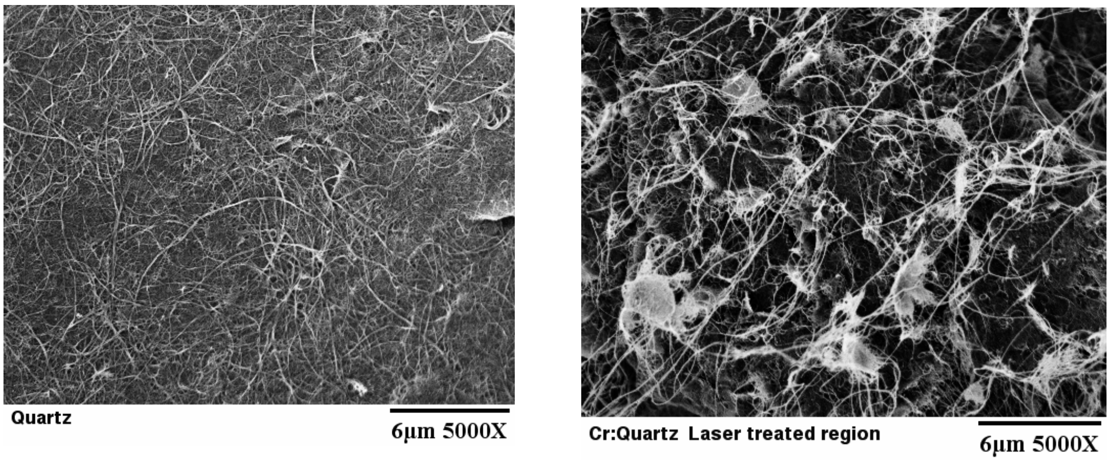

Figure 1. Before (left) and after (right) 248 nm laser exposure of bulk SWNTs.

Carbon nanotube samples possess different amounts and types of carbon impurities dependent upon the synthesis method and post treatment purification techniques employed. We investigate whether this laser treatment for purification is applicable to various nanotube materials. Different methods of laser treatment of nanotubes are also investigated in attempt to develop a scalable route to purification of bulk nanotubes.

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