Accessment of direct and indirect toxicological effects of carbon nanotubes - by Raman spectroscopy

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Raman spectroscopy has been demonstrated to have significant potential in the biosciences, delivering high throughput, high precision and multiplexed assays of biochemical state and biological function in biological species [1]. Cellular analysis using Raman spectroscopy has become increasingly popular in recent years with demonstrated applications ranging from disease diagnosis to classification of microorganisms and as a probe of molecular changes at a cellular level occurring as a result of external toxic exposures [2].

Carbon nanotubes have attracted considerable interest not only for their outstanding physical and electronic properties, promising a potentially vast number of applications, but also for their potential toxicological risks as nanoparticles [3]. Based on recent toxicological [4] studies we employ Raman spectroscopy for the determination of carbon nanotube mediated, direct and indirect toxicity on human alveolar carcinoma epithelial cells (A549) is demonstrated. The exposure of this cell line represents the primary pathway of exposure in humans, that of inhalation.

Univariate and multivariate statistical techniques will demonstrate the primary and secondary aspects of exposure to single-walled carbon nanotubes. Preliminary results showcase a dose dependent response which correlates well to previous toxicological studies. Independent component analysis is employed to further classify and collocate cellular response as a function of dose and to examine differences between spectra as a function of exposed concentration. This preliminary study strengthens the potential of Raman spectroscopy as a probe of cytotoxicity to nanoparticle exposure.

Keywords: Raman spectroscopy, biospectroscopy; single-walled carbon nanotubes; nanotoxicology; cytotoxicity, multivariate analysis, clonogenic assay, Imaging.

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