Measuring Uptake Dynamics Of Multiple, Identifiable Carbon Nanotube Species Via High-Speed Confocal Raman Imaging Of Live Cells

Daniel A. Heller, Jeon Woong Kang, Niyom Lue, Ramachandra R. Dasari

Memorial Sloan-Kettering Cancer Center

We observe the real-time uptake of individual single-walled carbon nanotube species into live macrophages via transient spatial Raman mapping. Signals from DNA-encapsulated carbon nanotubes, as well as lipid and protein signatures of the cells, are measured concurrently. The uptake of several individual carbon nanotubes is observed via strong Raman scattering of radial breathing mode (RBM) and intermediate frequency mode (IFM) features. The nanotubes are tracked spatially and temporally via rapid, continuous Raman spectral mapping of the cells with a frame-rate approaching one map per minute. The nanotube signals and cell-intrinsic lipid and protein signals are acquired concomitantly, allowing the localization of the nanotubes with respect to the cell position. Early in the experiments, RBM signatures of individual nanotubes account for the majority of the nanotube signal. After 15 minutes, however, the aggregate G-band signal becomes dominant, as multiple nanotube species out of RBM resonance flood the cells. This work demonstrates the real-time tracking of multiple, distinguishable, nanoparticles in cells via Raman mapping for applications in molecular probes, surgical markers, and contrast agents.