Abs. 538, 205th Meeting, © 2004 The Electrochemical Society, Inc.

Near-Infrared Fluorescence as a Tool for Developing Biomedical Applications of Single-Walled Carbon Nanotubes

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It is widely hoped that the unique properties of artificial nanomaterials such as single-walled carbon nanotubes (SWNT) will lead to important applications in biology and medicine. However, to develop such applications, researchers need a tool for tracing the location and fate of nanotubes in biological specimens. Recent advances in nanotube spectroscopy may provide an appropriate tool. It is now known that semiconducting SWNT emit detectable near-infrared fluorescence in the range of ca. 900 to 1600 nm.[1,2] Nanotubes with small average diameters (~0.9 nm), such as those formed through the HiPco process, provide emission peaked at wavelengths near 1200 nm, where biological tissues show minimal levels of light absorption and scattering. In addition, intrinsic or endogenous fluorescence from tissues is extremely weak at such wavelengths, and the large shift between SWNT excitation and emission wavelengths avoids interference from background Raman scattering. It is therefore possible to use near-infrared fluorescence as a selective and very sensitive method for detecting and visualizing the spatial distribution of SWNT in biological samples. As a first illustration of this method, we will present fluorescence spectra and images of SWNT that have been ingested by mouse macrophage cells through phagocytosis. The ingested nanotubes retain their fluorescent character and are observed to localize inside the phagosome vesicles of the macrophages. Prospects for further uses of SWNT fluorescence imaging in biological media will also be discussed.

References

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