Carbon Nanotube Biodegradation: Quantitative Assessment and Risk Management Perspectives.

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The widespread utilization of carbon nanotubes (CNTs) has raised concerns regarding their environmental and health impacts. Urgent attention is required to clarify their degradation for long-term safety assurance and the development of risk management strategies.

To investigate the biodegradation of CNTs, we developed a near-infrared (NIR) technique for quantitatively assessing post-cellular uptake of CNTs, conducting comprehensive in vitro and in vivo experiments. Our studies utilizing RAW 267.4 and Kupffer cells revealed approximately 40% degradation of single-wall CNTs (SWNTs) within these cells, correlated with the generation of reactive oxygen species (ROS) but devoid of cytotoxic effects [1]. Additionally, in vivo investigations outlined size and dispersant-dependent biodistribution patterns of SWNTs. Notably, post-intravenous injection in mice over a 60-day period showed decreased SWNT levels in the liver and lungs, while stable quantities remained in the spleen. Remarkably, SWNTs were nearly cleared from the lungs, indicating minimal pulmonary toxicity at lower concentrations [2].

Furthermore, we discovered complete degradation of CNTs via sodium hypochlorite treatment [3], notably accelerated by temperature and UV-irradiation [4]. This breakthrough offers a rapid and efficient strategy for eliminating CNTs from industrial wastewater. These findings deepen our understanding of CNT degradation mechanisms and contribute to safer handling, disposal, and risk management practices for CNTs.

References

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