Title: Facile ammonia-assisted CVD synthesis of ^{10}B-enriched boron nitride microtubes for targeted drug delivery and boron neutron capture therapy

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Abstract: Boron neutron capture therapy (BNCT) demands efficient, biocompatible vehicles for selective ^{10}B delivery to tumour cells, yet scalable synthesis of enriched boron nitride microtubes (^{10}BNMTs) remains elusive. Here, we present a streamlined ammonia-supported chemical vapour deposition (CVD) method for producing high-purity ^{10}BNMTs using nanosized ^{10}B, γ-Fe_2O_3, and MgO precursors at 1200 °C, yielding hierarchical nanostructures with micron-scale internal diameters (1–2 μm) and nanoscale wall thicknesses (<100 nm). FE-SEM reveals eggshell-like tubular morphologies evolving from capped capsules, while XRD confirms crystalline hexagonal ^{10}h-BN phase with peaks at 26.1°, 42.1°, 56.8°, and 76.6°. Raman spectroscopy shows a prominent E_2g mode at 1391 cm^{-1}, and FTIR spectroscopy identifies in-plane (1391 cm^{-1}) and out-of-plane (829 cm^{-1}) vibrations, both blue-shifted due to ^{10}B isotopic enrichment. These ^{10}BNMTs exhibit inherent biocompatibility and multifunctionality, combining bulk-like mechanical stability with nanoscale surface effects for encapsulating macromolecules in targeted drug delivery. Leveraging the high thermal neutron cross-section of ^{10}B (3840 b), they enable precise BNCT via $^{10}B(n,\alpha)^7Li$ reactions, generating total energy of 2.31–2.79 MeV where the kinetic energy of alpha particles is 1.78 MeV (ground state reaction) and 1.47 MeV (excited state reaction) for selective tumour ablation. This synthesis advances multifunctional nanomaterials for precision oncology and beyond.

Keywords: 10B-enriched boron nitride; Microtubes; BNCT; Nanoscale; Biomedical

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