

Abstract

The present document describes a carbon allotrope-silica composite material comprising a silica microcapsule comprising a silica shell, wherein said shell has a thickness of from about 50 nm to about 500 μm , and a plurality of pores, and said shell forms a capsule having a diameter from about 0.2 μm to about 1500 μm , and said shell has a density of about 0.001 g/cm³ to about 1.0 g/cm³, and said shell comprises from about 0% to about 70% Q3 configuration, and from about 30% to about 100% Q4 configuration; or said shell comprises from about 0% to about 60% T2 configuration and from about 40% to about 100% T3 configuration; or wherein said shell comprises a combination of T and Q configurations thereof, and wherein an exterior surface of said capsule is covered by a functional group; and a carbon allotrope attached to said silica microcapsule.

Also described is a carbon allotrope-silica composite material comprising a carbon allotrope attached to a silica moiety comprising a silica nanoparticle having a diameter from about 5 nm to about 1000 nm, wherein an exterior surface of said silica nanoparticle is covered by a functional group.

Also disclosed is the method to synthesis the carbon allotrope-silica composite by introducing carboncontaining plasmagenic gases or graphene oxides to silica. The carbon allotrope-silica composite preferably further comprises a molecule, a cell, an enzyme, and/or a viral particle