Carbon-Silica Hybrid Nanomaterials: Synthesis and Structural Characterization

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Hybrid carbon-silica mesoporous nanomaterials have drawn significant interest due to their ability to combine the synergistic benefits of silica and carbon inside a single ordered porous framework. These materials combine the large surface area, adjustable pore architecture, and chemical adaptability of silica with the electrical conductivity, mechanical robustness, and thermal resilience of carbon, leading to applications in catalysis, adsorption, energy storage, and sophisticated polymer composites. The surfactant aided sol-gel synthesis, especially with SBA type mesostructures, enables precise control of three-dimensional pore architecture via the cooperative self-assembly of triblock copolymeric surfactants, silica precursors, and carbon sources. The removal of the template followed by controlled carbonization produces well-structured carbon-silica hybrids. The temperature of carbonization dictates the degree of graphitization thus results partly graphitized carbon-silica nanoscale hybrid with tunable surface functionalities. Detailed spectroscopic, microscopic, and physical characterization provides insight into the morphology, porosity, and interfacial interactions. These synthesis driven structure-property relationships highlight the potential of carbon-silica hybrid nanofillers for high performance elastomeric and polymer composite applications.

References

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Figure

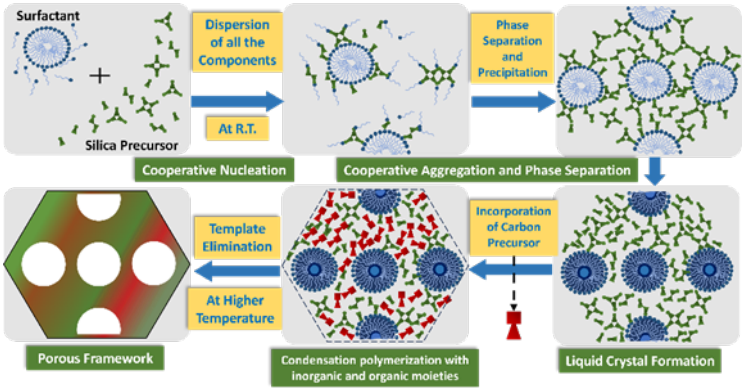

Figure 1: Schematic route of synthesis of hybrid carbon-silica nanomaterials via self-assembly method