

Carbon nano/micro structures created in near-critical/supercritical fluids via self-assembly/self-organisation

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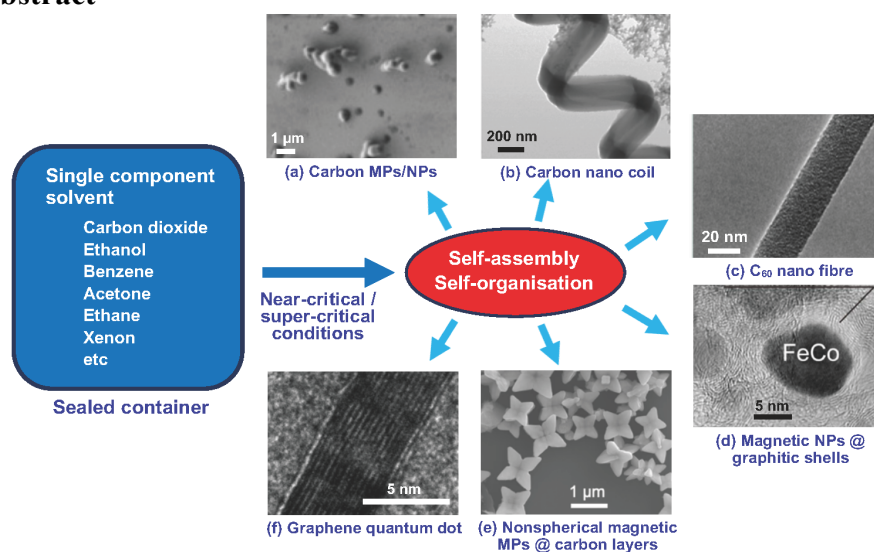
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Graphical Abstract



Abstract

The gas-liquid coexistence curves terminate at the critical points, which are in fact second-order phase transition points from a thermodynamic point of view. Large molecular clusters are formed as the fluid systems approach their critical points and finally percolate the fluid systems at the critical points. Supercritical fluids, the state of which is located above the critical points, possess unique properties such as high diffusivity, low viscosity and zero surface tension, thanks to which impurities contained in materials are efficiently extracted and chemical reactions are encouraged. Fundamental carbon nano structures such as fullerenes, carbon nanotubes and graphene are of great interest and importance as novel zero-, one- and two-dimensional ones, whereas they are also important from a practical point of view considering a wide range of applications in the fields of nano/micro mechatronics, electronics, chemistry, biochemistry, biotechnology, biomedicine, and environmental science and technology. Here, we focus on carbon nano/micro structures such as carbon nano/micro particles (NPs/MPs), fibres, coils, carbon quantum dots (CQDs) and magnetic particles covered with carbon layers, which are self-assembled in near-critical/supercritical fluids. Some of those carbon nano structures are summarised below.

- Carbon dioxide was dissociated and carbon NPs/MPs were formed in near-critical carbon dioxide via photolysis (UV laser irradiation). Importantly, CO₂ can be dissociated at room temperature, noting that the critical temperature of CO₂ is 31.0 °C.
- Benzene was dissociated and carbon nano coils were self-assembled in supercritical benzene via photolysis.
- Nano fibres were self-assembled by C₆₀ molecules, which were dispersed in near-critical CO₂, without laser irradiation.
- Magnetic NPs covered with graphitic shells were self-assembled in supercritical benzene, in which metallocene was dissolved, via photolysis.
- Nonspherical magnetic MPs covered with carbon layers were self-assembled in supercritical ethanol, in which metallocene was dissolved, via pyrolysis without laser irradiation.
- Carbon quantum dots such as nano graphene and carbon nano onions were self-assembled in supercritical acetone via pyrolysis without laser irradiation.

Keywords: Near-critical fluids; super-critical fluids; carbon nano structures; self-assembly; self-organisation

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