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# Spherical polyelectrolyte brushes: Ideal templates for preparing pH-sensitive core–shell and hollow silica nanoparticles

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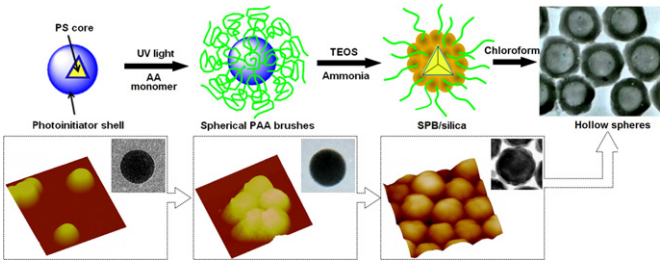
## HIGHLIGHTS

- A new method to prepare well-controlled hybrid and hollow nanoparticles was proposed.
- Silica was deposited in situ in spherical polyelectrolyte brushes by sol–gel process.
- The brush layers could guide the build of silica shell.
- The hybrid and hollow silica nanoparticles exhibited pH-response and redispersibility.

## GRAPHICAL ABSTRACT

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## ABSTRACT

Monodisperse silica-coated polystyrene core–shell nanoparticles (CSNs) and hollow silica nanospheres with a well-defined morphology and pH sensitivity were prepared using spherical polyelectrolyte brushes (SPBs) as templates. The anionic poly(acrylic acid) SPBs attached on PS cores played a pivotal role in directing and controlling the coating of silica by the Stöber method. A smooth silica shell with a uniform thickness was obtained as observed by SEM, TEM and AFM. Mechanism of silica coating in SPB was discussed. Effects of polyelectrolyte chains, salt concentration and temperature on the structure of silica layer were detailed. The prepared core–shell and hollow silica nanoparticles showed significant pH response and redispersibility as observed by DLS, which should be ideal candidates for promising applications in drug delivery, catalysis and functional materials.



## 1. Introduction

The synthesis of organic–inorganic core–shell nanoparticles (CSNs) consisting of a polymer core and a mineral shell or vice versa according to the precursor particles has received a lot of attention recently [1,2]. Such synthesis typically involves emulsion or dispersion polymerization [3,4], miniemulsion polymerization [5] or the entrapment of preformed polymer during sol–gel processes [6]. Their derivatives, inorganic hollow spheres, especially silica hollow spheres, possessing a porous morphology and tailored structure and exhibiting versatile characteristics such as non-toxicity, biocompatibility and high mechanical strength, have been the subject of extensive research due to their promisingly potential applications in many fields such as photonic, imaging materials, drug delivery and catalysis [7–11]. For the design of silica hollow sphere, different routes critically depended on a hard [12], soft [13,14] and/or sacrificial template [15] have been demonstrated in the literature. Now much effort has been devoted to preparation of particulate or colloidal polymer/silica CSNs based on colloidal technique. According to their coating process of silica, variously methods could be employed, principally involve sol–gel process [16], in situ heterophase polymerization [17] and self-assembly technique [18].

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