SURFACTANT-FREE SILICA-POLYMER ASSEMBLY: A NEW PARADIGM

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ABSTRACT:

Self-assembly holds great promise in understanding the sophisticated structures in nature and provides a solution to design functional materials with diverse applications.[1] It is well-known that mono-dispersed colloidal silica/polymer (e.g., resin) nanoparticles can be produced via the classic Stöber method.[2] Guided by surfactant templates, silica/polymer can also self-assemble into controllable mesostructures. In the absence of surfactants, however, the spontaneous organizing of silica and polymer led to typically core-shell-structures.[3] The full potential of this system and the assembly mechanism towards well defined nanostructures are largely underestimated.

In this presentation, I will introduce how the surfactant-free silica-polymer assembly system enables the synthesis of unprecedented nanostructured materials, the underlying mechanism and its difference compared to conventional surfactant packing parameter directed assembly systems.[4] Using the silica/polymer self-assembly system, my group has successfully fabricated a series of nanomaterials, such as mesoporous hollow carbon nanoparticles with tailored invagination,[5] adjustable pore sizes and versatile composition;[6] rough silica nanoparticles with rambutan-like nanotopography,[7] fractal meso-structure[8] and Janus architecture/composition.[9] These nanomaterials have shown excellent performance in energy storage and drug delivery applications. Our findings shed light on understanding the fundamental self-assembly mechanisms and provide novel strategies to fabricate functional nanomaterials with controllable structures and composition for diverse applications.

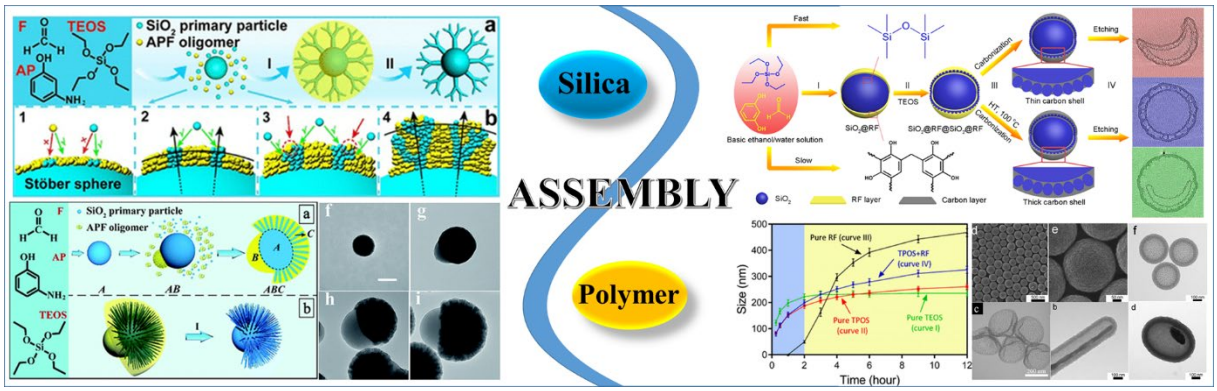

Figure 1: Surfactant-free silica-polymer assembly into functional nanomaterials with tailored morphology, meso-structures and compositions.

Reference:

1. (a) Yadav S, Sharma AK, Kumar P. (2020) Front. Bioeng. Biotechnol. 8: 127. (b) Palma CA, Cecchini M, Samorì P. (2012) Chem. Soc. Rev. 41(10): 3713-3730.
2. (a) Stöber W, Fink A, Bohn E. (1968) J. Colloid Interface Sci. 26 (1): 62-69. (b) Liu J, Qiao SZ, Liu H, Chen J, Orpe A, Zhao D, Lu GQ. (2011). Angew. Chem. Int. Ed. 123 (26): 6069-6073.
3. Fuertes AB, Valle-Vigón P, Sevilla M. (2012) Chem. Comm. 48 (49):6124-6126.
4. Xu C, Lei C, Wang Y, Yu C. (2021) Angew. Chem. Int. Ed. e202112752.
5. Zhang H, Yu M, Song H, Noonan O, Zhang J, Yang Y, Zhou L, Yu C. (2015) Chem. Mater. 27 (18): 6297-6304.
6. Zhang H, Noonan O, Huang X, Yang Y, Xu C, Zhou L, Yu C. (2016) ACS Nano, 10 (4): 4579-4586.
7. Song H, Yu M, Lu Y, Gu Z, Yang Y, Zhang M, Fu J, Yu C. (2017) J. Am. Chem. Soc. 139 (50): 18247-18254.
8. Fu J, Jiao J, Song H, Gu Z, Liu Y, Geng J, Jack KS, Du A, Tang J, Yu C. (2019) Chem. Mater. 32 (1):341-347.
9. Fu J, Gu Z, Liu Y, Zhang J, Song H, Yang Y, Yang Y, Noonan O, Tang J, Yu C. (2019) Chem. Sci.10 (44): 10388-10394.