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Nanomaterials – An Introduction

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ABSTRACT

Nanotechnology is booming and it has many applications in various domains of science and technology. This review discusses varoious aspects of nanomaterials and their uses as smart materials, surfactants, next generation devices, and as catalysts.

Keywords: Namotechnology, Nanomaterials, Catalysis

INTRODUCTION

Nanomaterials, which are materials that have some critical dimension between 1 and 100 nm and hence the nano world is full of surprises and potential. Over this intermediate scale, effects from the sub-micrometre- and micrometre- length scales can play equal roles and quantum effects[1] can intervene to give rise to fascinating properties. Confinement effects[1] lead to some of the most fundamental manifestations of nanoscale phenomena in materials and are frequently used as a point of departure for the study of nanoscience. Novel optical properties appear in nanoparticles as a result of such effects and are being exploited for information[2], biological sensing[3-6], and energy technologies[7-10].

The design and synthesis of three- dimensional (3D) supramolecular architectures with tunable, nanoporous, open channel structures have attracted considerable attention because of their potential applications as molecular sieves, sensors, size-selective separators, and catalysts[11-12]. An important class of three-dimensionally ordered nanomaterials is mesostructured nano-materials. Mesoporous materials are well known in heterogeneous catalysis and are of great interest because of our ability to tune their pore sizes from 1.5 to 10 nm. Mesoporous inorganic nanomaterials are synthesized in a multistep process based on the initial self-assembly of surfactant molecules[13] and block copolymers that self-organize into supramolecular structures. These supramolecular frameworks serve as structure-directing templates for the growth of mesostructured inorganic materials[13-20]. During a solvothermal reaction step, silica oxide particles form at the surfaces of the hexagonal rods, assembling around the supramolecular structures. The templating agent can be removed through an acid wash or by calcination to yield inorganic materials having hexagonal pores with uniform and controllable dimensions[21]. This porosity offers unique capabilities for both catalysis [22] and inclusion chemistry.

The shape of the surfactant, and the water content used during synthesis controls the resulting nanoarchitecture. Gemini surfactant is made up of two hydrophilic head groups and two hydrophobic tails per molecule, separated by a covalently bonded spacer. It can also be used to tailor the structure. For example, micelle forming block polymers have been used to fabricate silica nanofibres with hexagonal pores. Mesoporous nanomaterials also offer routes to functionalize pores to increase catalytic activity and selectivity. They have received much attention as host materials for the inclusion of numerous guests such as organometallic complexes, polymers, d-metal complexes, macromolecules, and optical laser dyes.

Photonic crystals[23-26] have attracted much attention as next-generation devices in which the refractive index changes periodically to show a photonic band gap. Various scientific and engineering applications, such as control of spontaneous emission, sharp bending of light, and so on, are expected to become possible by using the photonic band gap and the artificially introduced defect states and/or light emitters. Colloidal crystals are regular crystalline arrays of highly monodisperse spheres of dielectric materials such as silica or polymers. These materials have been the subject of study for several decades due to their unusual optical and thermodynamic properties. Progress in photonics is closely connected to the development of optical materials which allow new ways for controlling the dynamics of photons. Photonic Crystals comprise a novel class of such materials and are characterized by a spatially periodic modulation of the index of

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refraction. Multiple scattering from "dielectric atoms" leads to the formation of a photonic band structure, which may exhibit a complete photonic band gap for certain frequency ranges. Due to high demands on miniaturization, substantial progress in nanotechnology has allowed to consider the artificial manufacturing of photonic crystals for optical frequencies in a controlled way.

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REFERENCES AND NOTES

1. D. M. Lyons, K. M. Ryan, M. A. Morris, J. D. Holmes. *Nano Lett***2002**, 2, 811-816.
2. E. S. Michelson: Measuring the merger: Examining the onset of converging Technologies Springer, Berlin Heidelberg: New York, **2006**.
3. R. Elghanian, J. J. Storhoff, R. C. Mucic, R. L. Letsinger, C. A. Mirkin. *Science***1997**, 277, 1078-1081.
4. J. J. Storhoff, R. Elghanian, R. C. Mucic, C. A. Mirkin, R. L. Letsinger. *J. Am. Chem. Soc.***1998**, 120, 1959-1964.
5. R. A. Reynolds, C. A. Mirkin, R. L. Letsinger. *J. Am. Chem.Soc*.**2000**, 122, 3795-3796.
6. G. R. Souza, J. H. Miller. *J. Am. Chem. Soc.***2001**, 123, 67346735.
7. S. Coe, W.-K. Woo, M. Bawendi, V. Bulovic. *Nature***2002**, 420, 800–803.
8. J. Zhao, J. A. Bardecker, A. M. Munro, M. S. Liu, Y. Niu, I.-K. Ding, J. Luo, B. Chen, A. K.-Y. Jen, D. S. Ginger. *Nano Lett.***2006**, 6, 463–467.
9. L.Gur, N. A. Fromer, M. L. Geier, A. P. Alivisatos. *Science* **2005**, 310, 462–465.
10. P. V. Kamat. *J. Phys. Chem. C***2008**, 112, 18737–18753.
11. J. Y. Ying, C. P. Mehnert, M. S. Wong. *Angew. Chem.*, Int. Ed. **1999**, 38, 56-77.
12. K. J. C. Van Bommel, A. Friggeri, S. Shinkai. *Angew. Chem.*, Int. Ed. **2003**, 42, 980-999.
13. L. Qi, J. Ma, H. Chen, Z. Zhao, *Chem. Mater.* **1998**, 10, 1623-1626.
14. H. Yang, N. Coombs, G. A. Ozin. *Nature***1997**, 386, 692-695.
15. S. M. Yang, I. Sokolov, N. Coombs, C. T. Kresge, G. A. Ozin. *Adv. Mater.***1999**, 11, 1427-1431.
16. H.-P. Lin, Y.-R. Cheng, C.-Y. Mou. *Chem. Mater.***1998**, 10, 3772-3776.
17. H.-P. Lin, S. Cheng, C.-Y. Mou. *Chem. Mater*.**1998**, 10, 581-589.
18. H. Yang, G. Vovk, N. Coombs, I. Sokolov, G. A. Ozin. *J. Mater. Chem.***1998**, 8, 743-750.
19. Q. Huo, J. Feng, F. Schüth, G. D. Stucky. *Chem. Mater*.**1997**, 9, 14.
20. Y. Lu, H. Fan, A. Stump, T. L. Ward, T. Rieker, C. J. Brinker, Nature **1999**, 398, 223.
21. S. M. Yang, N. Coombs, G. A. Ozin **2000**, 12, 1940-1944.
22. J. Y. Ying, C. P. Mehnert, M. S.Wong, Angew. Chem. Int. Ed. **1999**, 38, 56.
23. C. Lopez Adv. Material **2003**, 15, 1679.
24. Yablonovitch, E. Phys. Rev. Lett. **1987**, 58, 2059-2062.
25. John, S. Phys. Rev. Lett. **198**7, 58, 2486-2489.
26. Joannopoulos, J. D.; Meade, R. D.; Winn, J. N. Photonic Crystals; Princeton University Press: Princeton, NJ, **1995**