Synthesis and Crystallization of Colloidal Particles

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Various Examples of Colloidal Particles

Nano-Scale

Meso-Scale

Au Colloids
Quantum Dots
Dendrimers
Silica Colloids

Polymer Latexes

Human Hair

Molecules
Proteins
Red Blood Cell

HIV Virus
E. Coli
White Blood Cell
Opals and Crystallization of Spherical Colloids

Natural Opals: Sanders, Nature 1964, 204, 1151

Large-Area Crystallization of Spherical Colloids

Park, Qin & Xia, Advanced Materials 1998, 10, 1028
Xia, Gates, Yin & Lu, Advanced Materials 2000, 12, 693
Two Examples of Crystalline Lattices

230-nm Polymer 1.0-mm Silica

Xia, Gates, Yin & Lu, Advanced Materials 2000, 12, 693

3D Crystalline Lattice of Polystyrene Beads

Xia, Gates, Yin & Lu, Advanced Materials 2000, 12, 693
Control over the Thickness of Crystalline Lattice

1-layer, $H=1.2$ μm, $D=1.05$ μm

2-layer, $H=1.2$ μm, $D=0.48$ μm

3-layer, $H=1.5$ μm, $D=0.48$ μm

4-layer, $H=2.0$ μm, $D=0.48$ μm

5-layer, $H=2.4$ μm, $D=0.48$ μm

25-layer, $H=12$ μm, $D=0.48$ μm

Flow Cells Fabricated Using a Simple Method

Lu, Yin, Gates & Xia, Langmuir 2001, 17, 6344
Experimental Set-Up and Two Typical Samples

Domain Structure of the Opaline Lattice
Opals Made of Polymer and Silica Beads

Template-Directed Crystallization of Spherical Beads
Growth of (100)-Oriented Crystalline Lattices

Yin, Li & Xia, Langmuir 2003, 19, 622
Yin & Xia, Advanced Materials 2002, 14, 605

Two (100)-Oriented Crystalline Lattices
Photonic Band Structure and Spectra

Control over the Spectral Position of Stop Band

Gates & Xia, Advanced Materials 2000, 12, 653; and 12, 1329
The Principle of Photonic Papers and Inks

A) Writing and Erasing

B) PS beads

C) PDMS swollen with the ink

Color Change in Response to Iso-Propanol

A) Image of colored paper

B) Image of red paper

C) Graph showing intensity vs. wavelength

D) Graph showing intensity vs. time
Color Inks Made of Clear Fluids: Silicone Oils

Color Change from UV to Vis and Vis to NIR

Fudouzi & Xia, Langmuir 2003, 19, 9653
Fudouzi & Xia, Advanced Materials 2003, 15, 892
Highlighted in Materials Today, 2003, December, 7
Writing and Stamping on Photonic Papers

Jiang, Herricks & Xia, Advanced Materials 2003, 15, 1205

Titania Precursor Beads of Various Sizes

Jiang, Herricks & Xia, Advanced Materials 2003, 15, 1205
Crystalline Lattices of Titania Colloids

Hollow Spheres with Interior Surfaces Functionalized by Nanoscale Particles

Yin, Lu & Xia, Chemistry of Materials 2001, 13, 1146
TiO₂ Hollow Spheres Whose Interiors Surfaces Are Functionalized with Silver Nanoparticles

Assembly of Au@SiO₂ Spherical Colloids

Lu, Yin, Li & Xia, Nano Letters 2002, 2, 785
Crystalline Lattice and Optical Spectra

Photonic Band Structure of the Diamond Lattice

Gates, Li, Lu, Yin & Xia
Advanced Materials 2001, 13, 411
Spheroidal Polymer Beads Made by Stretching

Lu, Yin & Xia, Advanced Materials 2001, 13, 271

Control over the Aspect-Ratio

Lu, Yin & Xia, Advanced Materials 2001, 13, 271
Hollow Spheroids (Egg Shells) Made of Titania

Fabrication of Au/SiO₂ Hybrid, Dimeric Colloids

Lu, Xiong, Xia, Prentiss & Whitesides, J. Am. Chem. Soc. 2003, 125, 12724
Colloids Consisting of Au and Magnetic Particles

- PS bead
- iron oxide
- silica
- carbon

Au@SiO₂@Polymer Double-Shelled Colloids

A

- TEOS coating
- Au particle

- Au@SiO₂

- sialation of ATRP initiator

B

- surface initiator
- catalyst ligand

- Au@SiO₂@Polymer

C

- HF etching
- Au particle within PEO/MA shell

- Au@SiO₂@Polymer@MA

- PEO/MA shell
Characterization by Back-Scattering SEM and TEM

Kamata, Lu & Xia, J. Am. Chem. Soc. 2003, 125, 2384

Monitoring Diffusion Across Different Shells