

Mesoporous 물질의 제조와 활용

김 지 만

아주대학교 응용화학전공 기능성물질연구실

<http://www.ajou.ac.kr/~fml>



Outline

- Mesoporous Materials ?
- Application Areas

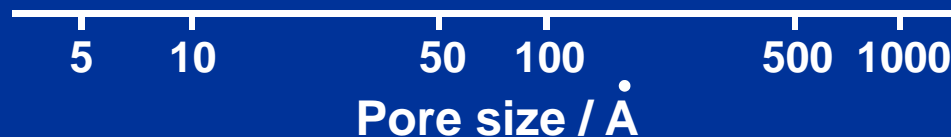
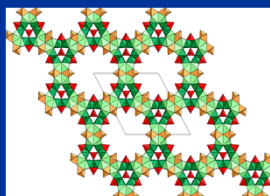
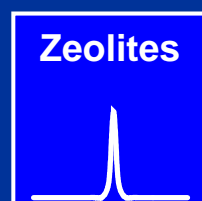
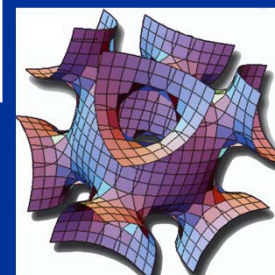
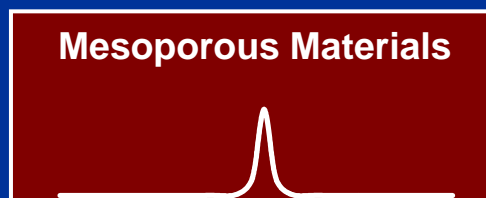
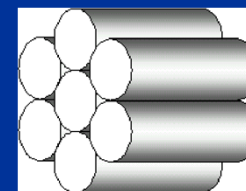


Porous Materials in Nanoworld

Microporous

Mesoporous

Macroporous



100 nm

**EM6736
x50k x5**

8 nm

Pore

Silica framework

Mesoporous Materials

- ✓ Controllable and large pore size in the range of 2 ~ 30 nm
- ✓ High surface area ~ 1000 m²/g
- ✓ MCM-, SBA-, MSU-, KIT-series

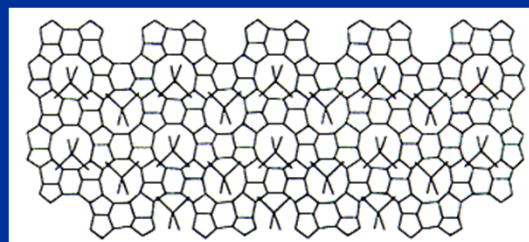
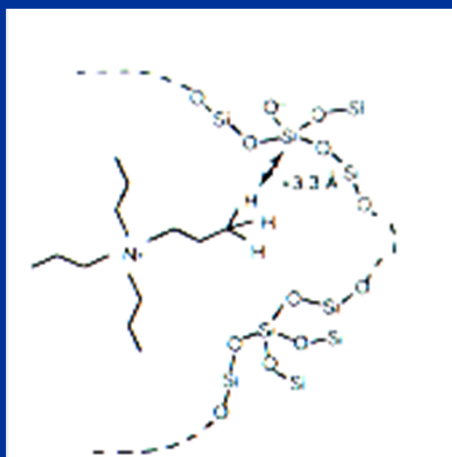


**Catalyst
Adsorbent
Sensor
Device**



Templates for Porous Materials

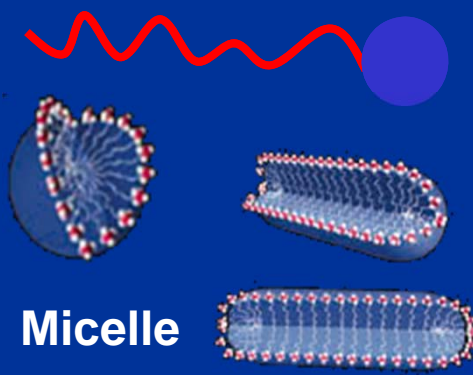
Molecules



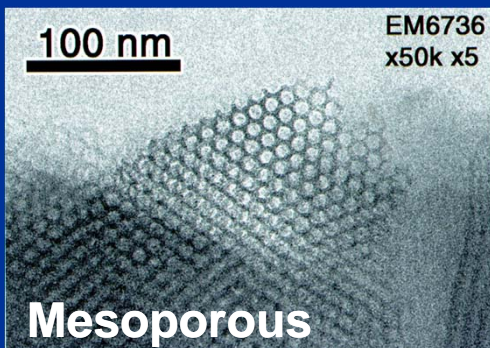
Microporous

Surfactant

hydrophobic Hydrophilic

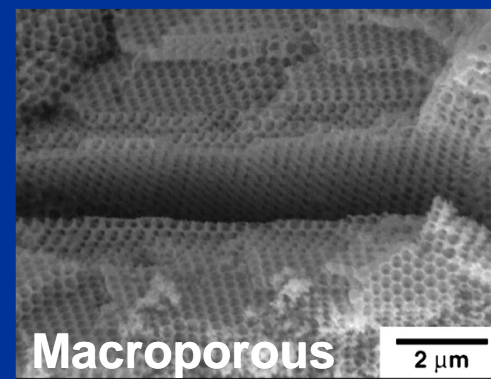


Micelle



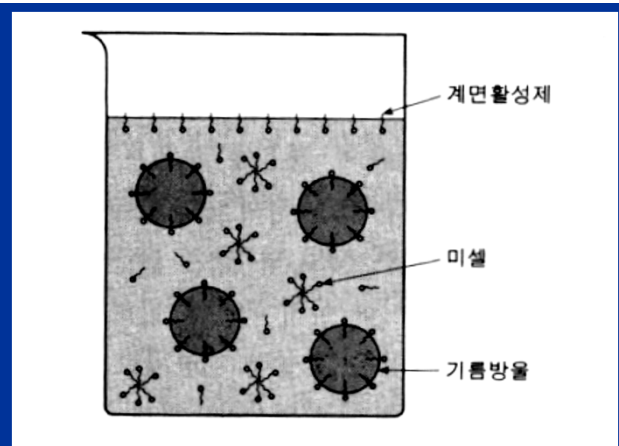
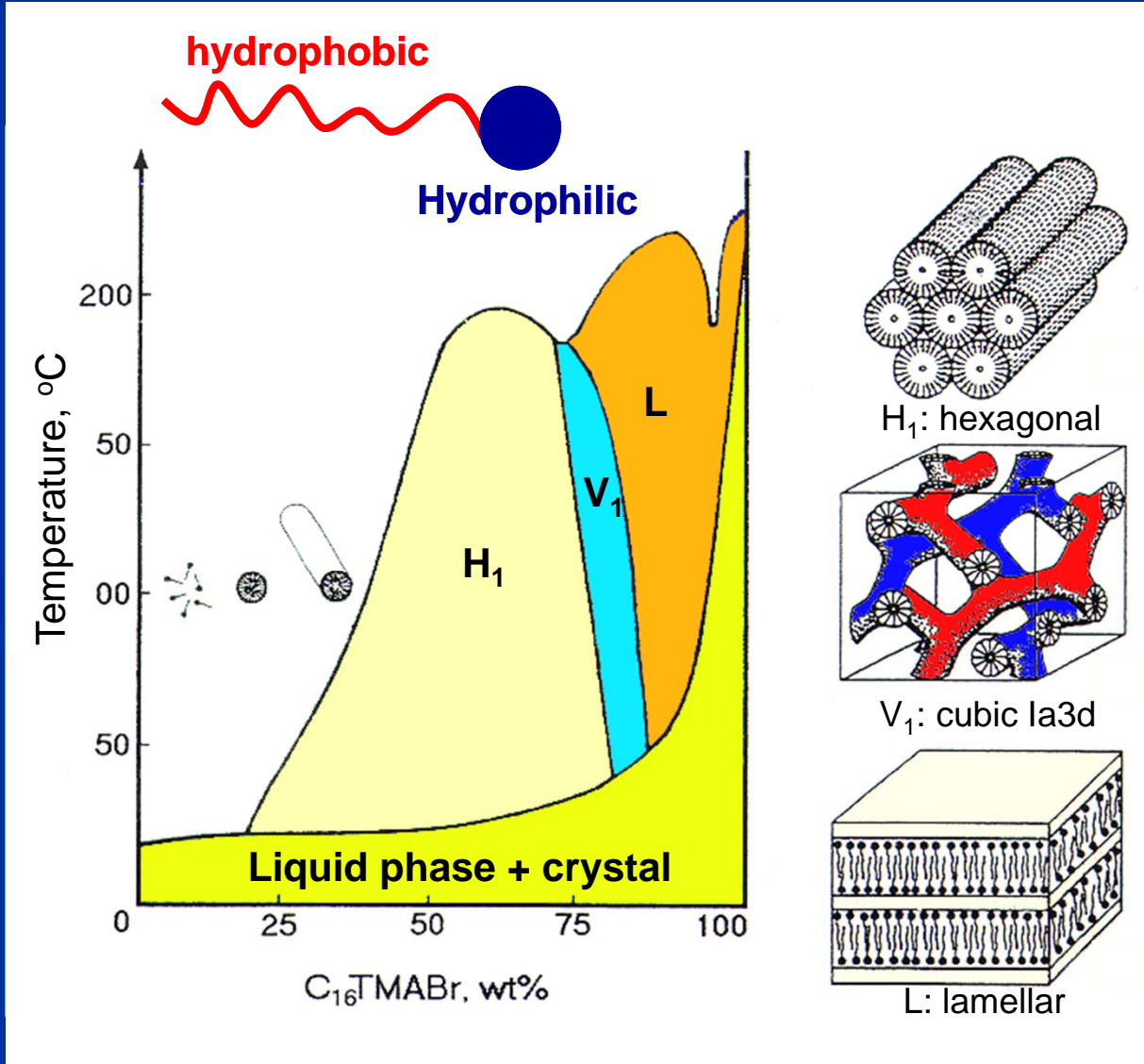
Mesoporous

Polymer Bead



Macroporous

Surfactant in Water



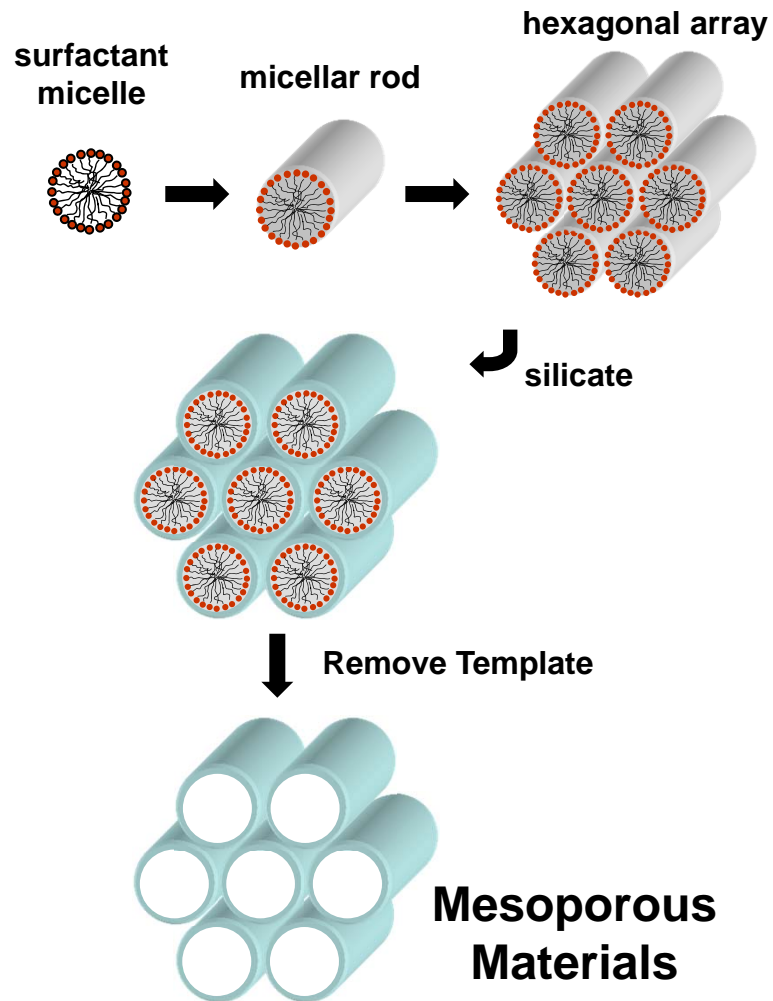
MCM-41

MCM-48

MCM-50



Mesoporous Materials

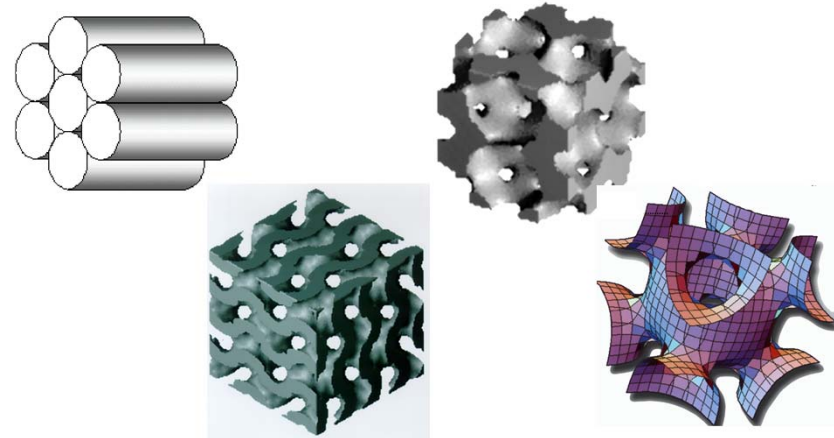


Nature, 1992, 359, 710

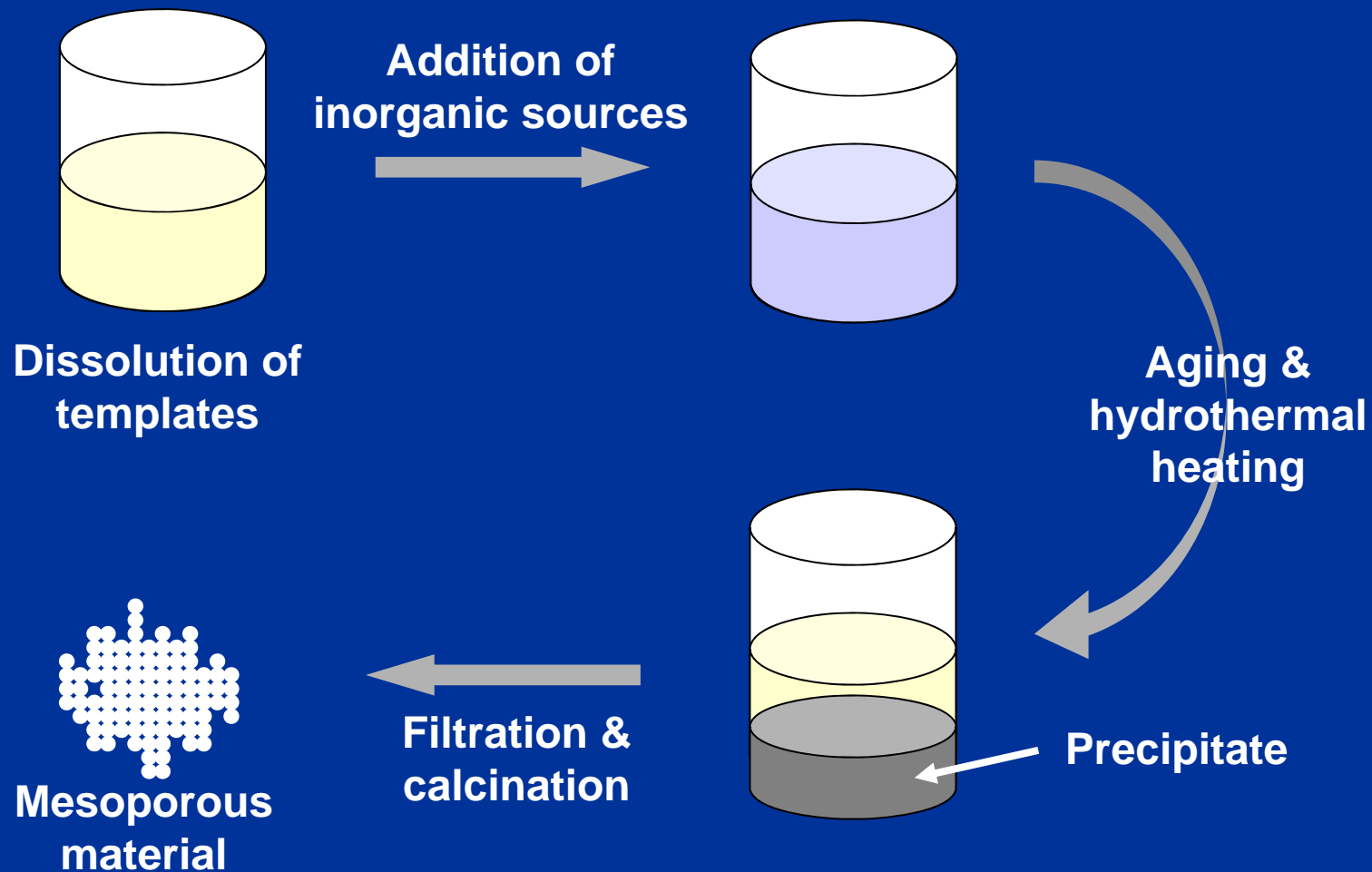
Variation of synthesis parameters

- ✓ Reactant concentration
- ✓ Synthesis temperature
- ✓ pH of the mixture
- ✓ Nature of surfactant, etc.

Pore Structure, Morphology & Framework



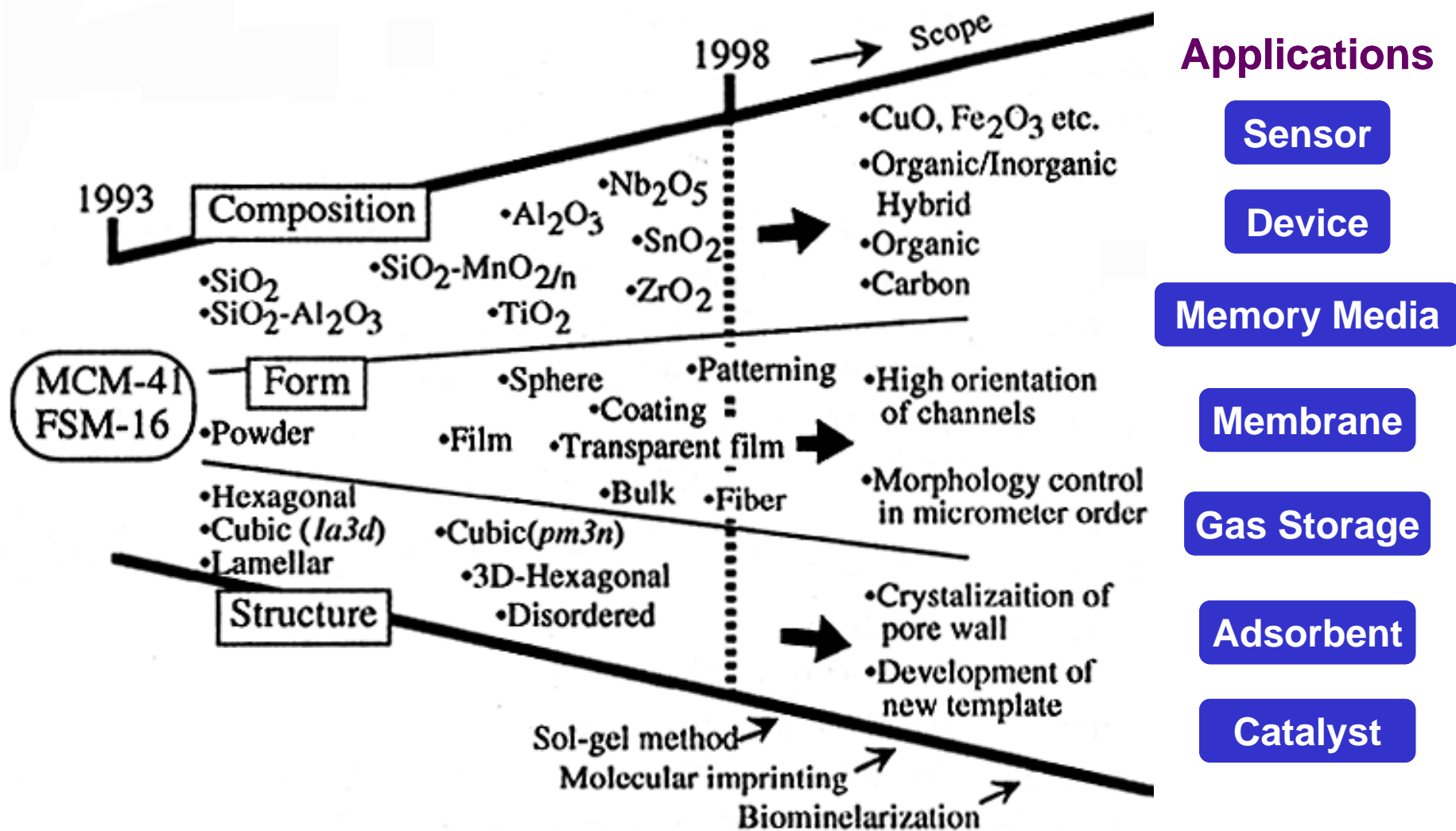
General Synthesis Scheme



Application Examples



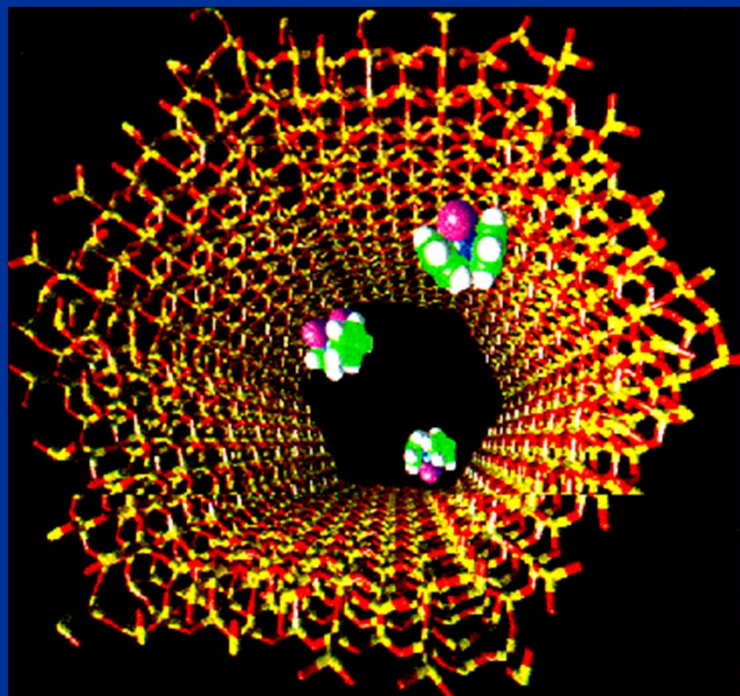
Possible Application Areas



Stud. Surf. Sci. Catal., 1998, 117, 65



Grafting Metallocene Complexes onto Mesoporous Silica

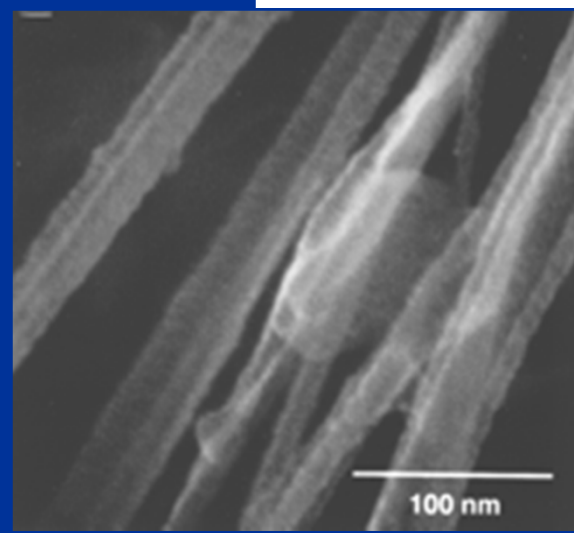
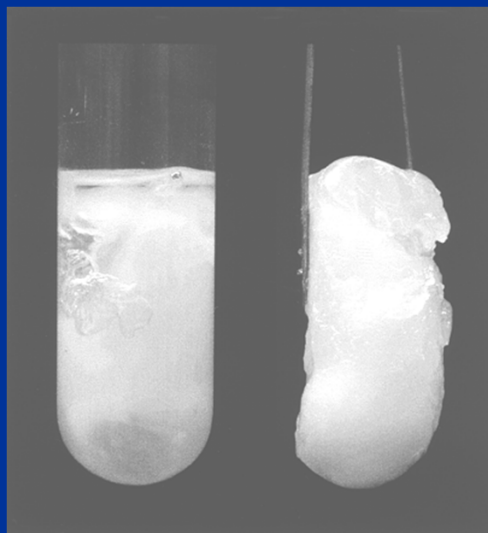
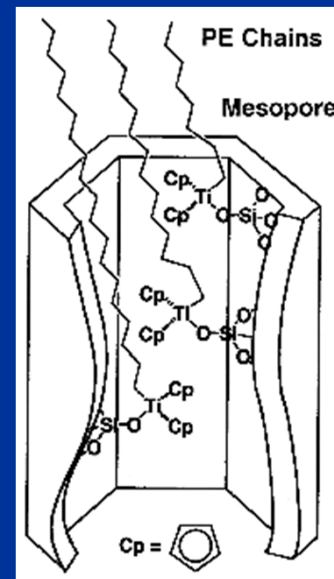
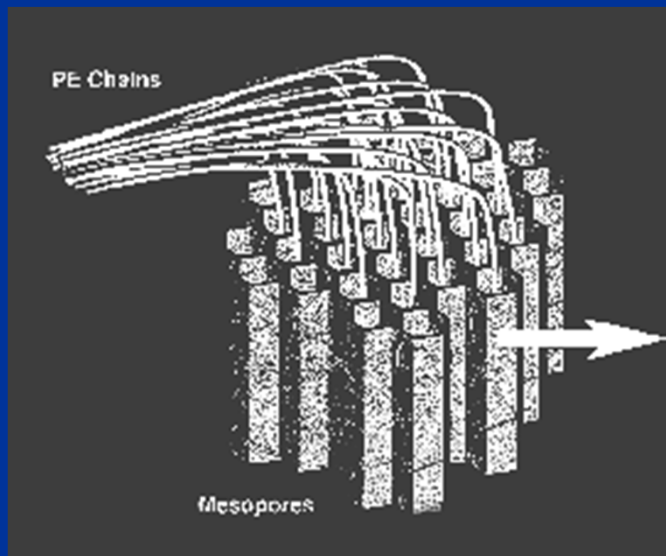


Direct grafting of an organometallic complex onto the inner walls of MCM-41 generates a heterogeneous catalyst with a large concentration of accessible, well spaced and structurally well defined active sites. Attachment of a titanocene-derived catalyst precursor to the pore walls of MCM-41 produce a catalyst for the **epoxidation of cyclohexene and more bulky cyclic alkenes.**

Nature, 1995, 378, 159



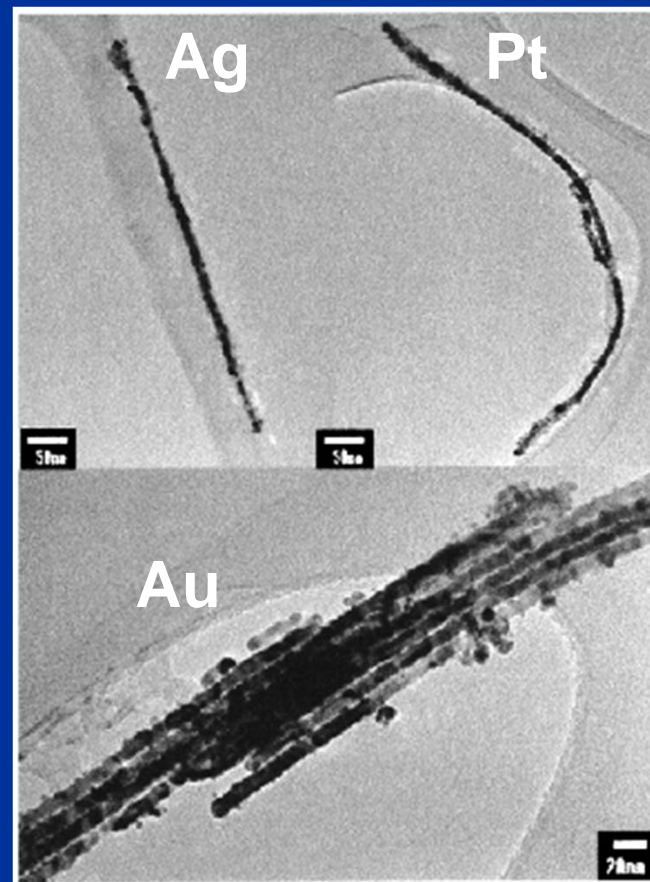
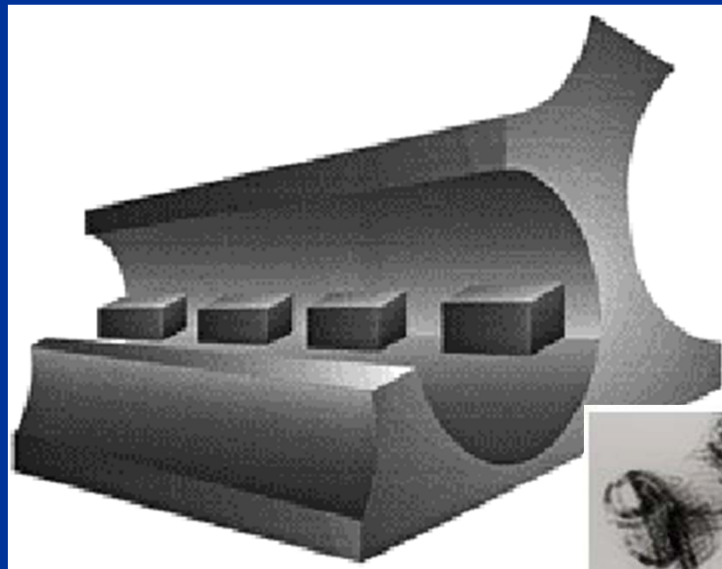
Nanoscale Polymerization Reactors for Polymer Fibers



Science, 1999, 285, 2113



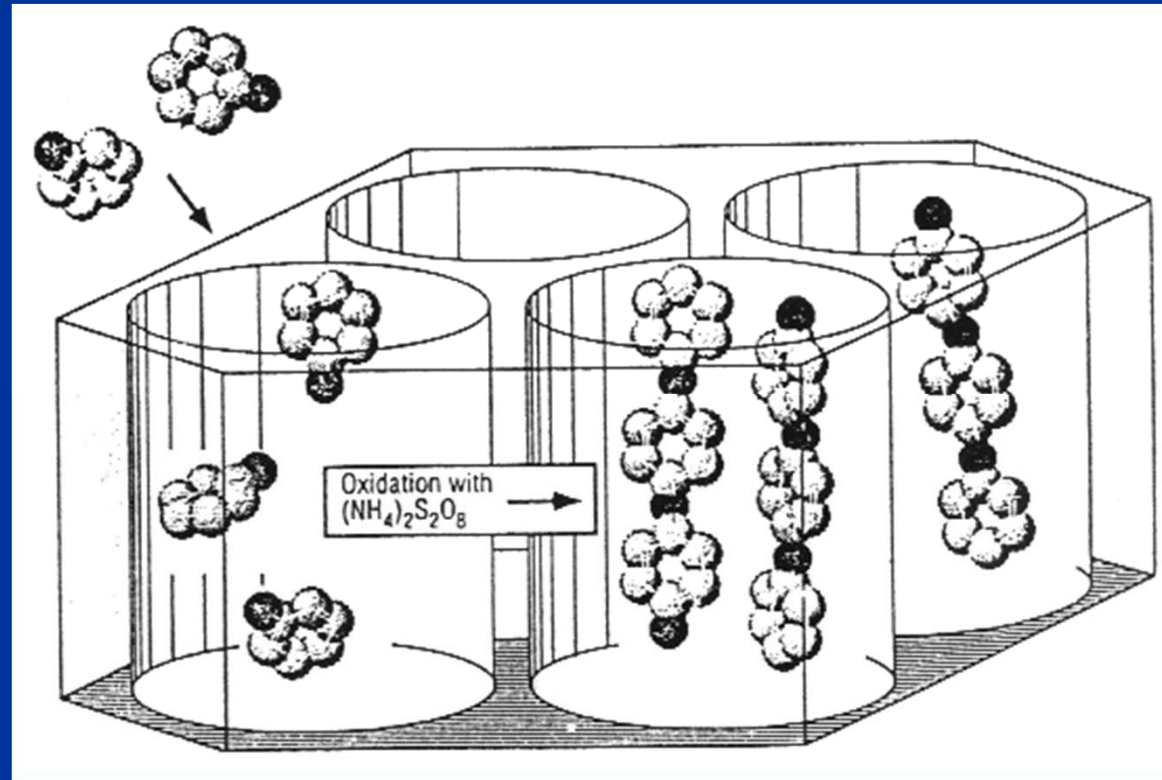
Metal Nanowire Fabrication



R. Ryoo et al., *J. Phys. Chem.*, **1996**, *100*, 17718
J. M. Kim et al., *Chem. Mater.*, **2000**, *12*, 2068



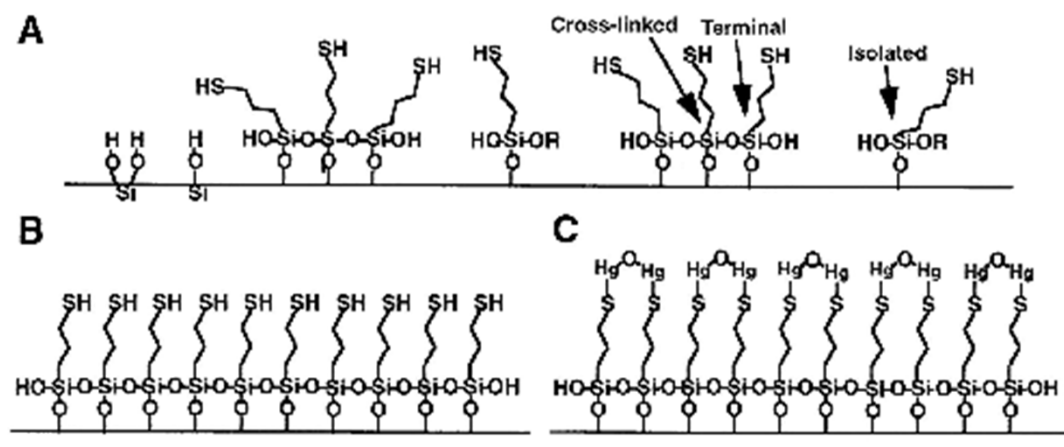
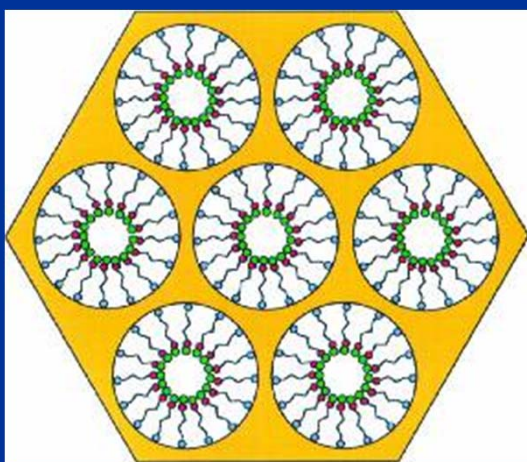
Conducting Polyaniline Filaments in Mesoporous Channel



This demonstration of conjugated polymers with mobile charge carriers in nanometer channels represents a step toward the design of nanometer electronic device.

Science, 1994, 264, 1757

Functionalized Monolayer for Environmental and Industrial Applications

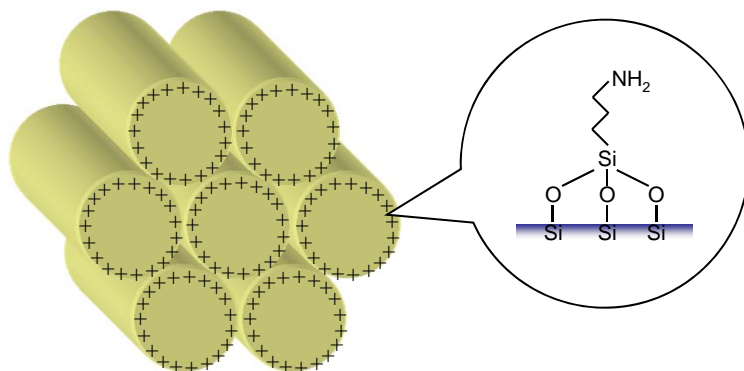


One end group of the functionalized monolayers is covalently bonded to the silica surface and the other end group can be used to bind heavy metals or other functional molecules. The materials are extremely efficient in removing mercury and other heavy metals from both aqueous and nonaqueous waste streams.

Science, 1997, 276, 923.

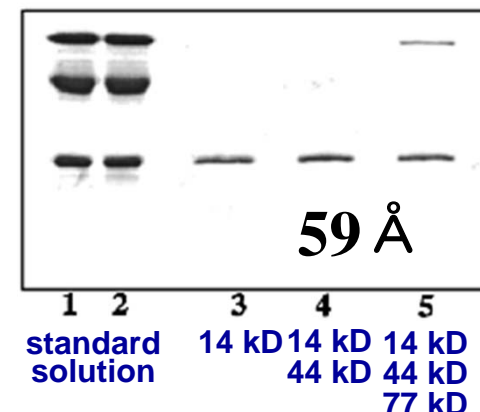
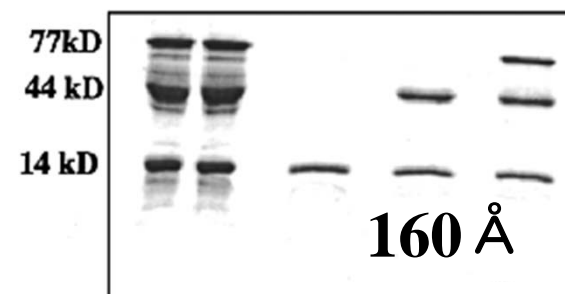
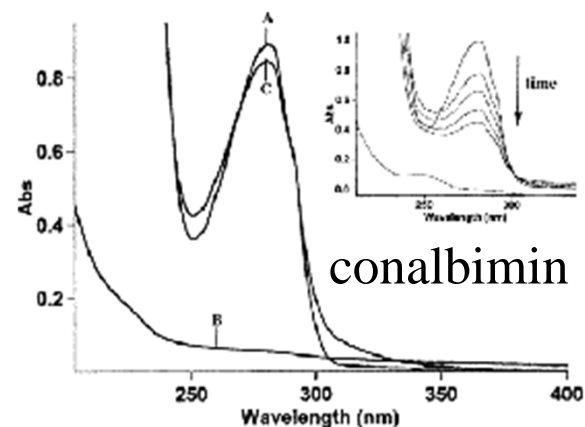
Protein Separation

SBA-15



SBA-15 with different channel sizes can be used for **protein separation** where both size exclusion and ion-exchange chromatography techniques are employed simultaneously.

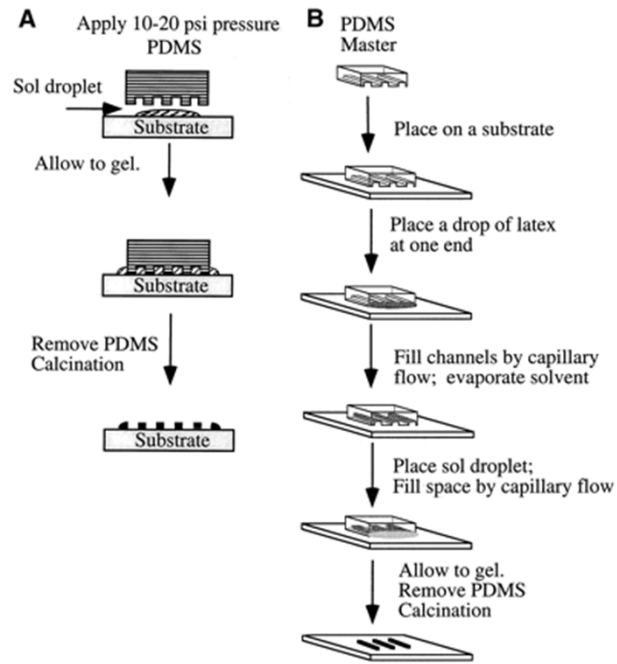
J. Am. Chem. Soc., 1999, 121, 9897



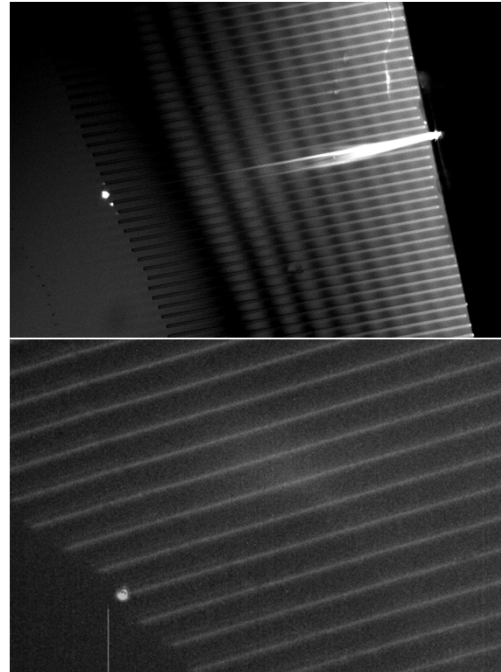
standard solution 14 kD 14 kD 14 kD
44 kD 44 kD 44 kD
77 kD



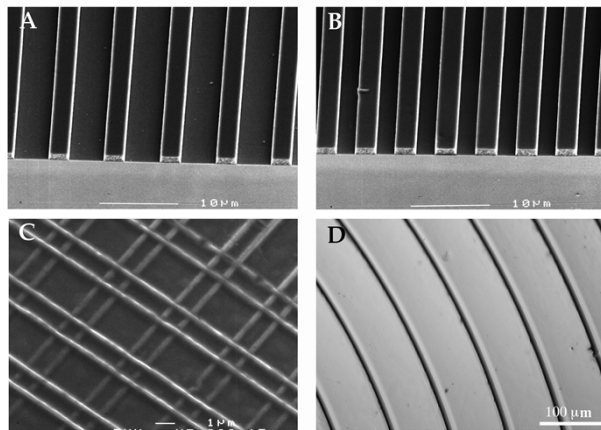
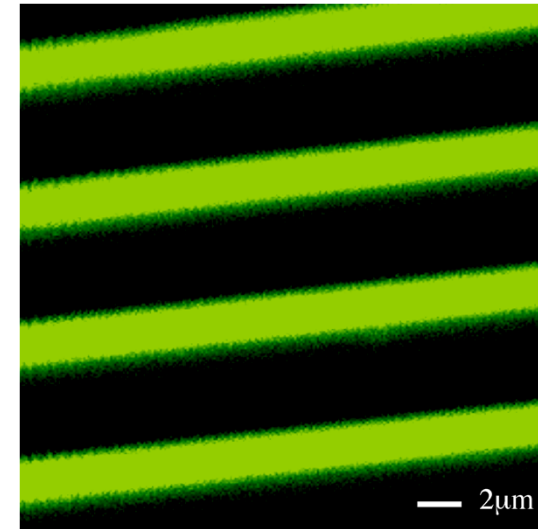
Mesostructured Waveguides Patterned by Soft Lithography



Low-loss waveguides



Homogenous dye distribution



These highly processible, self-assembling mesostructured host media and claddings may have potential for the fabrication of integrated optical circuits.

Science, 2000, 287, 465