Fabrication of Mesoporous Functionalized Arrays by Integrating Deep X-Ray Lithography with Dip-Pen Writing

Hilal SAGLAM

Department of Physics

Illinois Institute of Technology, Chicago, U.S.A

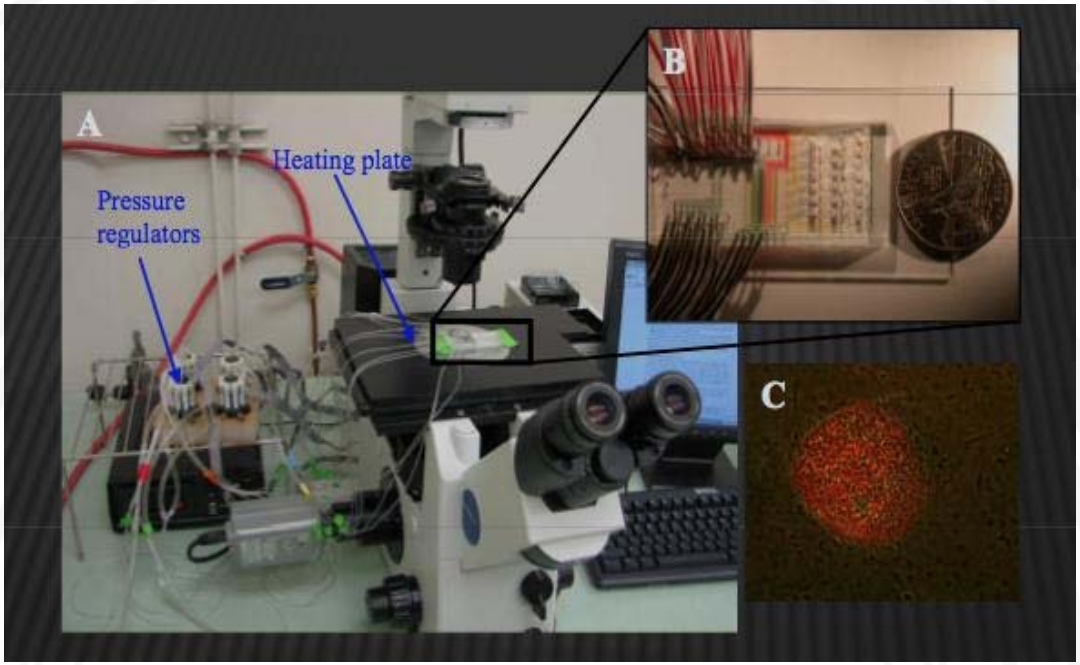
PHYS570-Introduction to Syncrothron Radiation

December 9, 2013

Outline

- Mesopores thin film structures
- X-Ray lithography
- Optical microscopy images
- Small angle X-Ray scattering (SAXS)
- SAXS results
- TEM results
- Conclusion

Mesopores thin film structures



Source : http://dujs.dartmouth.edu/news/lab-on-a-chip#.UqYGpPRdWKh

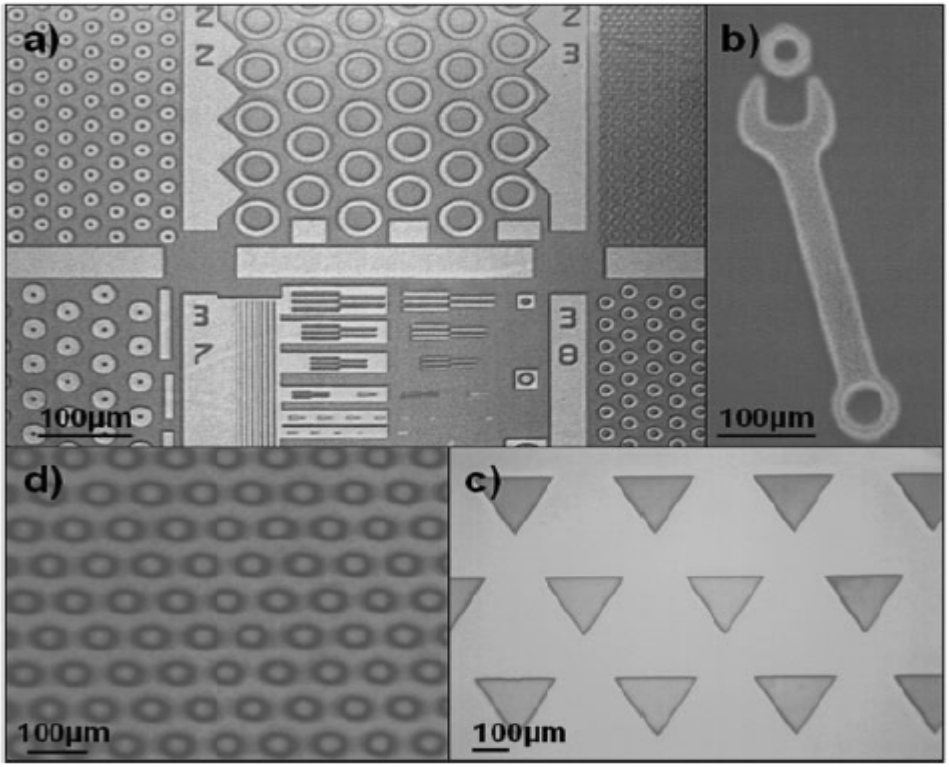
- ✓ Contains pores with diameter between 2 nm and 50 nm.
- ✓ Ideal host for functional organic molecules or nanoparticles.
- ✓ Allow the design of devices for different types of advanced applications such as lab-on-a-chip devices.

- ✓ Needs high technology
- ✓ More sophisticated lithograohic techniques to achieve higher definition
- ✓ capability to define patterns of complex nonperiodical shapes

X-Ray Lithography

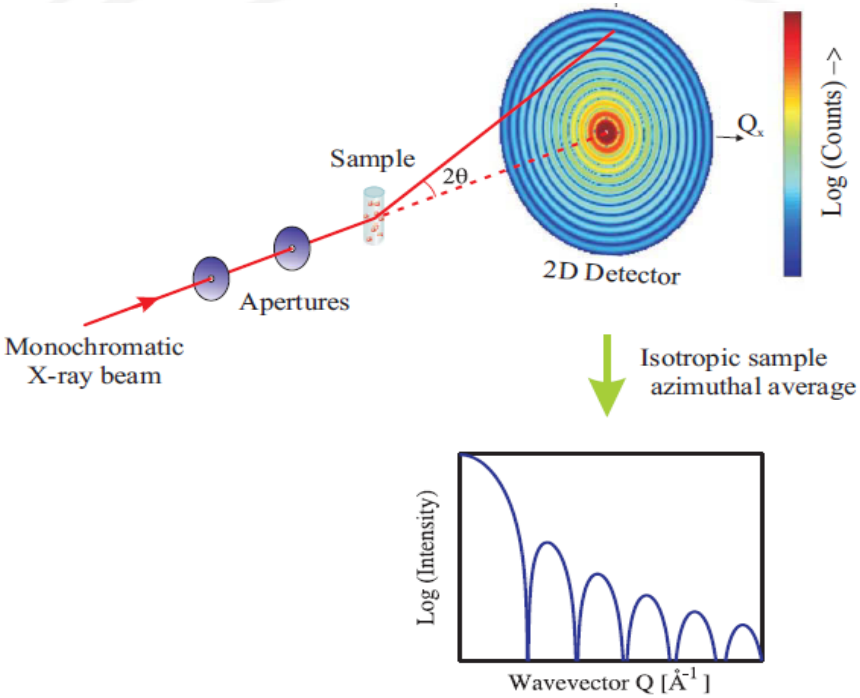
- To produce metal or plastic microstructures that feature sizes down to 1 μm or less
- High-resolution,
- High-intensity
- Extremely collimated synchrotron radiation

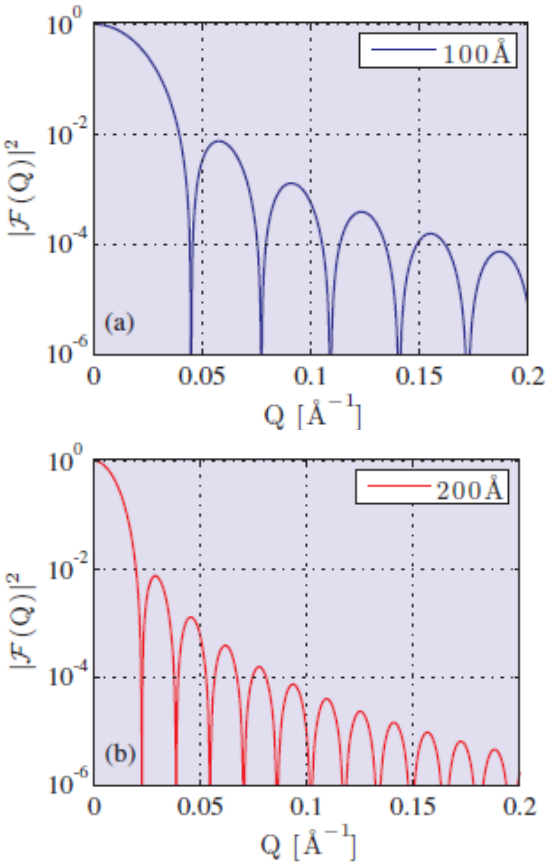
Optical Microscopy Images



- ✓ Figure shows the optical imgaes of patterned mesostructured films (a-d)
- ✓ The optical microscopy was used to make sure the quality of the lithographic process
- ✓ The patterned areas appear white becuase of owning different refractive index.

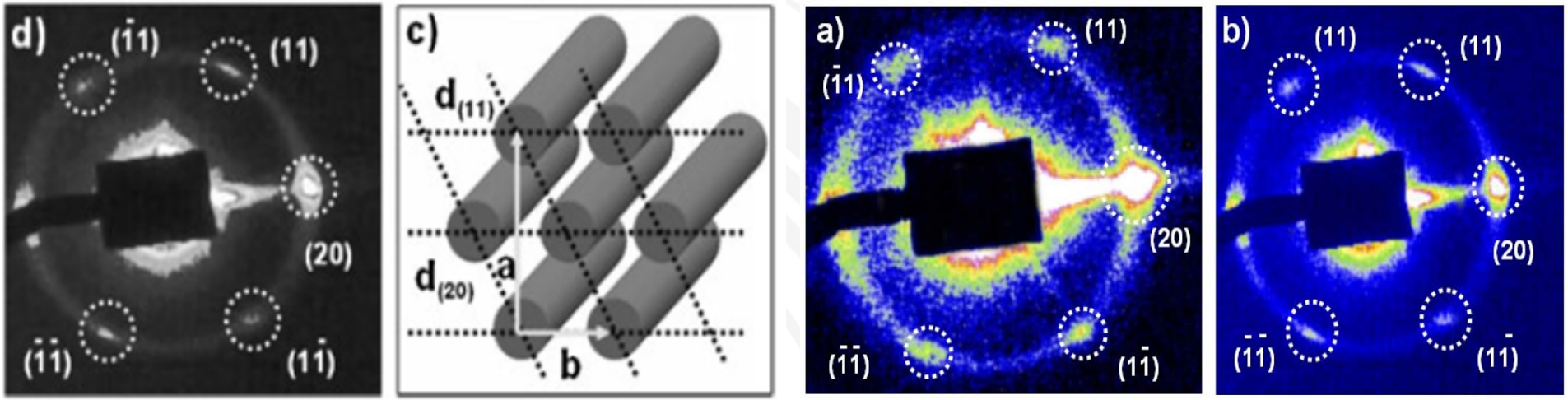
Small-angle X-ray scattering (SAXS)





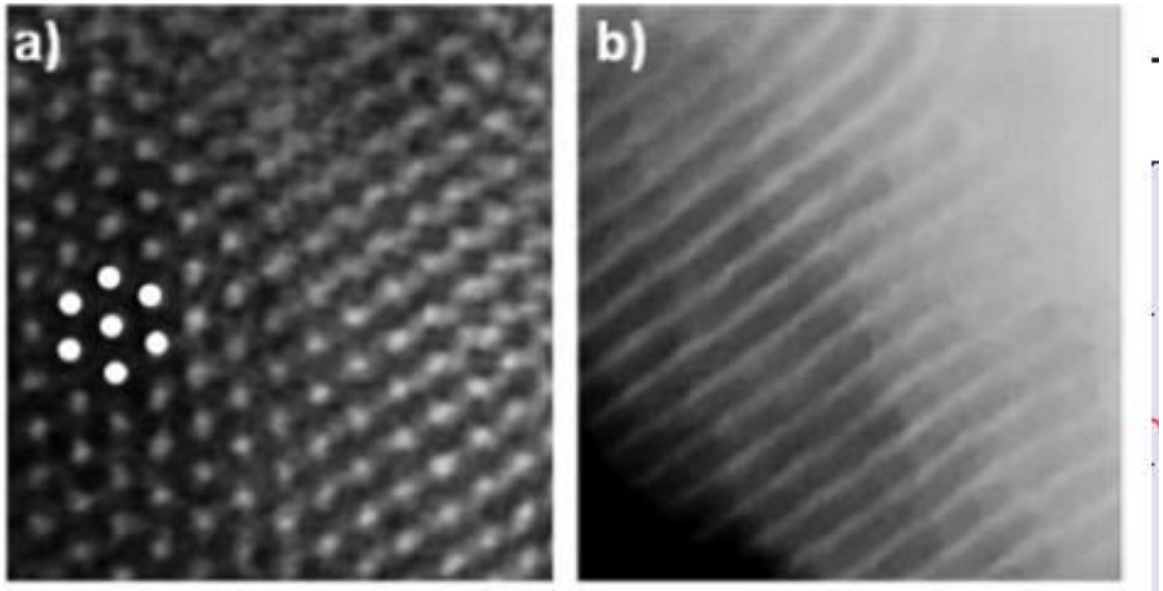
✓ Elastic scattering of X-Rays by a sample is recorded at very low angles (0.1^{o}-10^{o}) since these angular range containes information about the shape and size of microstructures.

SAXS Results



- The SAXS data reveals a p6m symmetry group (d).
- Hexagonal p6m mesostructures allow accessibility of the material from the outside and diffusion of analytical species into the material,
- It opens a new route for efficient immobilization of biological species in analytical applications (c).

TEM Results



- TEM images represent the shape of the cylindrical mesopores (a,b)
- The lateral feature size of the patterned pillars corresponds to the conditions fo rmicroarray deposition.

CONCLUSION

- The results show that it is possible to fabricate highly fluorescent mesoporous microstructures by the functionalization of micrometric mesoporous objects.

- The patterned mesoporous support maximizes absorption of guest molecules owing to the high specific surface area of mesoporosity

- Hexagonal mesostructures associated with cylindrical pores allow accessibility of the material from the outside and diffusion of analytical species into the material, opening the route for efficient immobilization of biological species in analytical applications

- This experiment has also demonstrated that the etching process completely removed the unexposed region of the film, leaving no residue of the film on the substrate


Thank You