Mesoporous Silica Materials

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Mesoporous silica offers promising possibilities for many applications, including biomedicine, catalysis, and adsorption. This talk reviews recent developments in the synthesis and applications of mesoporous silica from Mou’s laboratory at National Taiwan University. I will discuss the control of morphology(thin film, nanoparticle and hollow spherical) and surface functionalization in synthesis.

1. Hollow silica nanosphere were developed for many applications in Catalysis and Biomedicine
   - ■ Enzyme(HRP) encapsulated hollow silica nanospheres for intracellular biocatalysis.
   - ● Intracellular Implantation of Enzymes in Hollow Silica Nanospheres for Protein Therapy: Cascade System of Superoxide Dismutase and Catalase
   - ● Enzymatic Nanoreactors of HRP@Hollow Silica for Intracellular Sensing of Reactive Oxygen Species.

2. Large Area silica thin films(MSTF) with vertical orientation of pores were synthesized in free-standing and supported form. Their formation mechanism was studied by TEM, SEM, GISAX, in-situ SAXS and SANS. In free standing form, SBA-15 of micron-size and ~100 nm thickness was made. The formation of the film is a result of the confinement effects of a silica deposition vesicle and silica transport vesicle which is much in analogy to the formation of the silica frustule of diatom. After surface functionalization, large amount of AuCl4- ions can be adsorbed and chemical reduced on top of the MSTF. A hexagonal 2-D array of gold nanoparticles, in wafer size, can be produced. Strong SERS effect was demonstrated on the two-dimensional gold nanoparticle array. The SERS effect is due to large amount of hot spots developed in the narrow gap(~ 1 nm) in the array.

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Boundary layer flows induced by a solitary wave

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In this presentation I will discuss the bottom boundary layer flows under a solitary wave propagating over a constant depth or running up a uniform slope.

First, approximate analytical solutions for a laminar bottom boundary layer flow will be discussed for the case of constant depth (Liu and Orfila 2004). The flow reversal occurs near the bottom during the deceleration phase for relatively small Reynolds numbers. Laboratory experiments were performed to check the analytical results (Liu, Park and Cowen 2007). Laboratory experiments also demonstrated that for larger Reynolds numbers, vortex tubes were triggered near the bottom (Sumer et al. 2010). The results of linear instability analysis will be discussed (Sadek et al. 2015). For even larger Reynolds numbers boundary layer flows eventually become turbulence.

I will also discuss some of the new (experimental and numerical) findings for swash flows generated by a non-breaking solitary wave on a constant slope (Higuera et al. 2017). The feature of boundary layer flow reversal also occurs during the uprush phase. However, during the down rush phase a hydraulic jump occurs and a series of vortices are generated from the boundary layer in the vicinity of the jump. The effects of contact angle and meniscus in the vicinity of moving shoreline will also be briefly discussed (Park, Liu and Chan 2012).

The following references might be useful for reader:

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2. Liu, P. L-F. Park, Y.S. and Cowen, E. A. (2007) Boundary layer flow and bed shear stress under a solitary wave. *J. Fluid Mech.*, 574: 449-463. http://dx.doi.org/10.1017/S0022112006004253.
3. Sumer, B. M., Jensen, P. M., Sorensen, L. B., Fredsoe. J., Liu, P. L.-F., Carstensen, S. (2010) Coherent structures in wave boundary layers. Part 2. Solitary motion. *J. Fluid Mech.*, 646, 207-231. http://dx.doi.org/10.1017/S0022112009992837.
4. Sadek, M. M., Parras, L., Diamessis, P.J., and Liu, P. L.-F. (2015) Two-dimensional instability of the bottom boundary layer under a solitary wave. *Phys. Fluids*, 27, 044101(2015). http://dx.doi.org/10.1063/1.4916560
5. Park, Y.S., Liu, P. L-F. and Chan, I-C. (2012) Contact line dynamics and boundary layer flow during reflection of a solitary wave. *J. Fluid Mech.*, 707: 307-330. http://dx.doi.org/10.1017/jfm.2012.280
6. Higuera, P., Liu, P. L-F., Lin, C., Wong, W-Y., Kao, M-J. (2017) Laboratory-scale swash flows generated by a non-breaking solitary wave on a steep slope. (in revision)