

Environmental and Chemical Engineering Seminar

*The USC Astani Department of Civil & Environmental Engineering and
Mork Family Department of Chemical Engineering & Materials Science present*



Prof. Manish Kumar
Chemical Engineering and
Environmental Engineering
Penn State University

Date: October 16, 2015

Time: 3 - 4 pm

Place: GFS 106

Artificial Aquaporins

Biological membranes combine high permeability with high selectivity, a feature that is challenging to replicate in synthetic systems. This is due to the presence of specialized proteins such as the water channel protein, aquaporin, present in biological membranes. Current artificial analogs of aquaporins, carbon nanotubes (CNTs), are challenging to synthesize in sub nanometer dimensions and difficult to align in membrane systems. There has been interest in artificial water channels that can be created using synthetic chemistry. In this talk I will discuss results from a new architecture of artificial water channels, peptide-appended-pillar[5]arenes (PAPs). The average single channel osmotic permeability for PAPs is $1.0(\pm 0.3) \times 10^{14}$ cm³/s or $3.5(\pm 1.0) \times 10^8$ H₂O molecules/s, which is within the range of biological water channels aquaporins ($3.4\text{--}40.3 \times 10^8$ H₂O molecules/s) and CNTs (9.0×10^8 H₂O molecules/s). This is orders of magnitude improvement over first-generation artificial water channels reported before. PAP channels combine and improve upon the advantages of protein channels and CNTs through their relatively simple synthesis, chemical stability, simple alignment in membranes and efficient cross-sectional area ($\sim 33\%$ effective pore area/channel vs $\sim 0.8\%$ for aquaporins and $\sim 68\%$ for CNTs(12,12). The ability to chemically modify the versatile chemical architecture of the pillar[5]arene channels shows promise for further improving water permeability and selectivity.

About the Speaker

Dr. Manish Kumar is an assistant professor of Chemical Engineering and Environmental Engineering at Penn State. He received his bachelors from the National Institute of Technology in Trichy, India in Chemical Engineering. He completed masters in environmental engineering at the University of Illinois and then worked for approximately seven years in the environmental consulting industry on applied research projects primarily centered around membranes for water. He returned to Illinois to complete a PhD in the area of biomimetic membranes and then conducted postdoctoral research at the Harvard Medical School on the structure of water channel proteins, aquaporins. He works in the areas of biophysical transport characterization of membrane proteins, membrane protein enhanced synthetic membranes and devices and on developing artificial membrane proteins. His group also works on improving reverse osmosis membrane processes to prevent biofouling and colloidal fouling.