DESIGNING NANOCHANNELS BY BLOCK COPOLYMER MICELLES ASSEMBLY

Suzana P Nunes[a], Klaus-Viktor Peinemann[a], Pradeep Neekalanda[a], Madhavan Karunakaran[a], Rachid Sougrat[a], Bobby Hooghan[a], Ali Reza Behzad[a] and Ulla Vaino[b]

[a]King Abdullah University of Science and Technology, Saudi Arabia
suzana.nunes@kaust.edu.sa

[b]DESY-HASYLAB, Hamburg, Germany

ABSTRACT

Films with high pore density and regularity are key components for the fabrication of new generations of magnetic arrays for storage media, medical scaffolds, and artificial membranes. Membranes for nano- and ultrafiltration are available for decades, but their morphology is characterized by broad pore size distribution or, when higher pore uniformity is achieved, the porosity is quite low. We combine the self -assembly of block copolymers in solution, directed by polymer-metal complexation and conventional methods of membrane preparation based on phase inversion and solvent-non-solvent exchange to obtain films with ultra-high porosity and exceptionally uniform pores. Block copolymers are known to form fascinating morphology due to repulsion of immiscible blocks. Complex structures can be tailored in solution, by choosing the right solvent mixture. However since in many cases the desired morphology is far from equilibrium their application to membrane manufacture is only possible in the presence of additives, which stabilize it and drastically decrease the system mobility. We demonstrate an unique method by casting solutions of copper (II) ion-polystyrene-b-poly(4-vinylpyridine) complexes in a mixture of dimethyl formamide and tetrahydrofurane, followed by phase separation in water. Analogous manufacture was demonstrated by using other metal ion complexes. Extremely high pore densities and uniformity were achieved. Water of L m -2 fluxes 890 h-1 bar^{-1} were obtained, which are at least 1 order of magnitude higher than those of commercially available membranes with comparable pore size. The pores are also stimuli (pH)-responsive, opening perspectives of application as chemical gates. The mechanism of pore formation was investigated by atomic force microscopy, cryo-transmission electron microscopy and tomography, cryo-field emission scanning electron microscopy, focused ion beam and synchrotron small angle X-ray scattering.