190b Preparation and Characterization of Silica Films with Aligned Cylindrical Mesopores on Porous Substrates

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Mesoporous ceramic thin films have many potential applications in areas such as membrane based separations, electronic materials, and sensors. When surfactants are used to template the mesopores, we can control both the size and shape of the pores. 2D hexagonal close packed cylindrical pores are of particular interest because they are of nearly monodisperse nanometer-scale diameter, and yet they do not provide lateral paths for diffusing species. However, when these structures are formed by evaporation-driven self-assembly, the cylindrical pores are usually found aligned parallel to the film surface because of preferential interactions between the surfactant molecules and the substrate on which they are cast. Here, we will present the first direct TEM evidence that 2D hexagonal close-packed pores can be aligned orthogonal to silica films deposited by dip coating. This is accomplished by coating the substrate with cross-linked copolymer films to create surfaces which are chemically neutral toward the head and tail of the surfactant template (the nonionic triblock copolymer P123). Complete orthogonal alignment of the pores is possible either by sandwiching a films between two chemically neutral surfaces, or by casting very thin films (<100 nm thick). We will present evidence that the method of dip coating mesoporous ceramic films onto crosslinked copolymers can be extended to prepare uniform, defect-free orthogonally aligned mesoporous silica coatings on commercially available porous substrates (such as anodized alumina membranes). We will show that we can then utilize the small mesopores of the orthogonally aligned silica films to perform size selective separations of small nanoparticles. This separation is not possible in mesoporous films which are not orthogonally aligned. Ultimately, this method of thin film formation can be used to produce arrays of nanopores with well defined diameter in ceramic films of arbitrary composition and functionality.