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Structure Formation of Block Copolymer Membranes

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Isoporous membranes have received increasing attention during the last couple of years. The advantage of these materials is to give access to membranes with a very high number density of pores with controlled diameters, thus leading to ultrafiltration membranes with a very high permeability, and simultaneously also with a very high selectivity in terms of size exclusion. Different approaches have been reported, which typically involve the transfer of a thin block copolymer film from a solid to a porous support, eventually followed by an edging step. An alternative strategy is to form integral asymmetric membranes, where the thin top layer is continuously changing into a spongy support layer, thus avoiding the build-up of mechanical stresses. This happens by subjecting the cast polymer solution film into a precipitant, inducing the so-called phase inversion by exchange of solvent with the non-solvent. Here it is important to have a system where solvent and nonsolvent are fully miscible. This strategy also enables the direct formation of open pores without a subsequent edging step, if the solvents and nonsolvents are appropriately chosen. Different types of amphiphilic block copolymers based on styrene, 2- or 4-vinyl pyridine, and ethylene oxide with various compositions and molecular weights will be discussed. These block copolymers were dissolved at different concentrations in various solvent mixtures, and then cast on a non-woven support, which was either pretreated with a liquid, or not. Varying the time before the cast solution was subjected to phase inversion, as well as choosing the temperature of the precipitation bath, are further parameters having strong influence on the obtained membrane film structure. Membranes with pore forming blocks showing pH or temperature sensitive behaviour can be reversibly switched from an open state to a closed state. The size of the pores can be controlled by both molecular weight and composition of the block copolymers.