Processing and Fabrication of Porous Polymeric Materials

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In this presentation, three different **schemes (foaming, drying and freezing) of easily preparing porous materials are introduced** together with their processing principles: **Nanocellular foam**, which possesses 40-200 nm scale pores in its plastic body, was prepared from polymer blends as well as from a pseudo-interpenetrating network polymer (IPN) by a physical foaming with supercritical carbon dioxide ($scCO_2$). We used the nanoscale-ordered spherical (sea-island) morphology of polymer blend as a template for bubble nucleation and growth and designed the dispersed domain (island) to serve as internal "soft" surfaces that not only induce the heterogeneous nucleation and growth of bubbles but also serve as CO_2-philic reservoirs to trap CO_2. **The second method** to be introduced is a **solvent evaporation** or drying, which can make 1-15 mm open pores in polymer film. Two polymers and solvent were selected so that the solvent was the good solvent for one polymer but poor solvent for the other. By exploiting the phase separation of one polymer induced in the course of dry casting, **a polymeric film with a fine porous structure** was prepared from the polymer blend solutions. The last one will be **directional freeze and freeze drying technique**. A **honeycomb monolith porous structured material** was fabricated from Poly(L-lactic acid) (PLLA) as well as colloidal silica particle solution by a simple unidirectional freezing. The method takes advantage of a solid-liquid phase separation induced during freezing and uses the resulting solid phase as a template for controlling pore structure. This unidirectional freezing method could be directly applied for nano-particle packing and colloidal crystals preparation. We could produce **a honeycomb monolith structure with highly ordered, three-dimensionally interconnected, macro-porous walls, i.e., inverse opal structure,** by applying the freezing technique to colloidal suspension, which is composed of two kinds of monodispersed nano-particle. All three schemes are simple and different. However, there was something in common: the porous structures were created by controlling the mass transport in the material and onset timing of phase separation during the processing.