Impact of freezing conditions on the morphology and mechanics of PVA-based sponge-like materials

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Abstract.

Highly porous polymer materials have been studied a lot with regard to its applications in biotechnology and tissue engineering. This is associated with their exclusive properties being extensive surface area and percolated pore structure. Varying polymer nature and processing conditions we can tune morphology, mechanical, and physicochemical characteristics of the materials. In the present work, we have studied chemically cross-linked poly(vinyl alcohol)-based highly porous freeze-dried sponges with various degrees of crosslinking by glutaraldehyde. Poly(vinyl alcohol) (PVA) is a water-soluble synthetic polymer. Due to its good biocompatibility PVA is widely used for wastewater treatment, biomaterials in tissue engineering, drug delivery, etc. The current study analyzes the influence of freezing speed on the morphology, surface area, mechanical, and physicochemical properties of the materials. During experiments, the promising approach for the freezing speed detection based on turbidimetry was applied. Also, the degrees of supercooling in the different freezing conditions were evaluated. Morphology of the materials was examined using environmental scanning electron microscopy, which allows surveying the pore structure in the swollen state. Compression tests asserted the dependence between the freezing conditions and the material's mechanical properties, as well as the impact of crosslinking degree. Generally, complex analysis of the tests carried out shows agreement in morphology, surface area, equilibrium degree of swelling, and mechanical properties of developed highly porous materials with visible dependence on the amount of cross-linking agent and freezing conditions.