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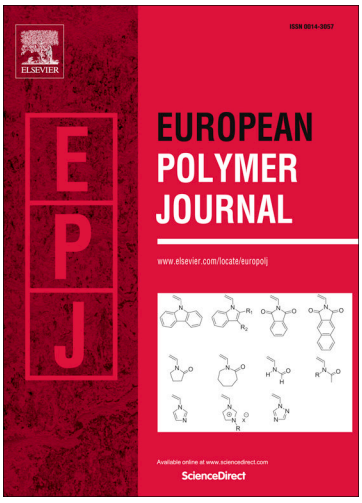

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Nermin Orakdogen, Berran Sanay

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Tailoring the physico-chemical properties and elasticity of poly(hydroxy-functional methacrylate)-based cationically charged gel beads: Combined hydrophobicity and mechanical durability through frozen droplets

Nermin ORAKDOGEN* **and Berran SANAY**

Istanbul Technical University, Department of Chemistry, Soft Materials Research Laboratory, 34469, Maslak, Istanbul, Turkey, Tel: +90-212-285-3305, Fax: +90-212-285-6386
e-mail: orakdogen@itu.edu.tr

Abstract

This study describes the experimental methodology to obtain hydroxy-functional methacrylate-based gel beads in millimeter-sized under production conditions by addition of the frozen pre-gel solution into the silicon oil as continuous phase using tetraethyleneglycol dimethacrylate (TEGDMA) as the crosslinking agent. Weakly basic cationic comonomer *N*,*N*-dimethylaminoethyl methacrylate (DMAEMA) was included into the polymerization procedure for the production of uniform poycationic moities exhibiting a drastic response against pH. The aim of this work is to determine the actual conditions for optimum bead production and to provide poly(hydroxypropyl methacrylate-co-*N*,*N*-dimethylaminoethyl methacrylate)-based P(HPMA-co-DMAEMA) gel beads with simple tools for the physical characterization. By the proposed experimental method, the physico-chemical properties of P(HPMA-co-DMAEMA) gel beads can be controlled by adjusting the pH, temperature of solution, ionic strength as well as the structure of the gel network. From the uniaxial compression tests, the swelling dependent stress-strain characteristics of resulting gel beads was evaluated. The obtained results were consistent with Hertzian elasticity, and were analyzed in terms of the Young's modulus of the bead samples. It was found that force acting on the gel beads is the power-law function of the deformation $F \approx \Delta D^{1.48}$ which is very close to the theoretical exponent 1.5 predicted by the Hertz equation. The water absorption capacities of P(HPMA-co-DMAEMA) gel beads with basic functional groups were repeatedly measured to obtain the optimal preparation conditions according to the variations of the bead diameters. Its maximal water absorption capacity appeared as 48 times among from 2.3 mm to 11.0 mm of swollen bead diameters. The swelling equilibria in various aqueous solutions were used to estimate the physico-chemical parameters as a function of gel bead size and swelling equilibrium capacity by correlating with the Flory-Rehner theory.

Keywords: Hertzian elasticity; hydroxypropyl methacrylate; *N*,*N*-dimethylaminoethyl methacrylate; gel bead; swelling; pH-responsive