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Synthesis and Swelling Properties of Thermosensitive Hydrogels based on Terpolymerization

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Abstract: **N**ovel thermosensitive hydrogels based on polymerization of N-isopropyl acrylamide, Sodium acrylate, and diacetone acrylamide were synthesized. The swelling ratio and dynamic swelling were investigated. The results indicated that the hydrogels exhibited high water uptake and themosensitivity. The swelling properties and volume phase transition temperature could be adjusted by contents of the comonomers in the gels.

Keywords: Hydrogel, thermosensitivity, swelling property.

Thermoreversible hydrogels have received increasing interest because of their various applications[1-3]. Poly(N-isopropyl acrylamide) (NIPA) has been widely studied in recent years due to its excellent thermosensitivity. When NIPA is copolymerized with a highly hydrophilic comonomer, swelling ratio of the polymer increases but volume phase transition temperature shifts to a high range. To solve this problem we prepared some new hydrogels. The lower critical solution temperature (LCST) of the hydrogels can be adjusted by hydrophilic and hydrophobic components.

The hydrogels were synthesized through free radical copolymerization of isopropyl acrylamide (NIPA), sodium acrylate (SA), and diacetone acrylamide (DAA). The gels were crosslinked with diethylene glycol dimethyacrylate (DED), and the reactions were initiated by benzoyl peroxide (BPO), reacting in a mixed solvent of water and dioxane. The synthetic conditions were listed in **Table 1**.

Table 1 Preparation of thermosensitive hydrogel by terpolymerization

Hydrogel No	NIPA (g)	SA (g)	DAA (g)	Molar ratio (NIPA/SA/DAA)	DED (g)	Solvent (ml)	BPO (g)
NSD-1	2.26	0.094	0.507	100 / 5 / 15	0.0878	5.0	0.025
NSD-2	2.26	0.094	0.676	100 / 5 / 20	0.0915	5.5	0.025
NSD-3	2.26	0.094	0.845	100 / 5 / 25	0.0951	6.0	0.025
NSD-4	2.26	0.094	1.014	100 / 5 / 30	0.0987	6.5	0.025

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Figure 1 Effect of temperature on the swelling hydrogels.

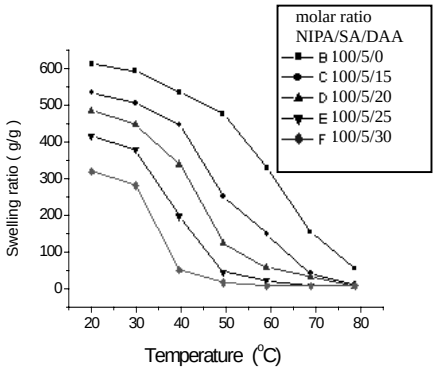
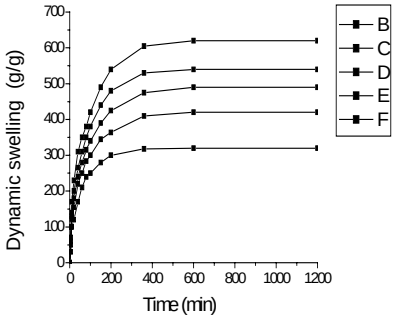


Figure 2 Dynamic swelling ratio of Ratio of hydrogels



The molar ratio of NIPA/SA/DAA in **Figure 1** and **Figure 2** was: B, 100/5/0; C, 100/5/15; D, 100/5/20; E, 100/5/25; F, 100/5/30.

The swelling ratio and dynamic swelling in deionized water for the hydrogels were investigated with the gravimetric method. The results were showed in **Figure 1** and **Figure 2**.

Obviously **Figure 1** shows clearly that the swelling ratios for the hydrogels are much higher than that of pure polymer of NIPA. This is due to the introduction of sodium acrylate. For a gel without DAA, although the swelling ratio is high, the deswelling is very difficult, and no definite phase transition temperature is observed. However if DAA is incorporated into the hydrogel, the phase transition temperature will decrease. When a proper content of DAA incorporated into the gel, the phase transition temperature can be adjusted to less than 40°C. The dynamic study indicates that the swelling rate is fast during the first 30 minutes and levels off gradually.

References

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