Sol-Gel Transition and Gelation Kinetics of Poly(ethylene oxide)-Dimethylformamide Solution

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The sol-gel transition and the crystallization kinetics of poly (ethylene oxide) (PEO) in dimethylformamide (DMF) were investigated by using differential scanning calorimetry (DSC). It was found that the clearing temperature of gels from visual inspection are almost the same as the corresponding melting temperatures from DSC. Therefore, the gel formation was thought to arise from the crystallization of PEO. The gel melting temperature (Tm) increased with PEO concentration in the gel. The equilibrium melting temperature (Tm^o) and the stability parameter (ϕ) were determined from Hoffman-Weeks plot. The equilibrium melting temperature (Tm^o) increased with PEO concentration in the gel; however the stability parameter (ϕ) did not change with PEO concentration. From Avrami plot, the values of Avrami exponent(n), kinetic rate constant(k) and the reciprocal of crystallization half time($t_{1/2}^{-1}$) were determined as a function of PEO concentration and the degree of supercooling(ΔT). It was found that the reciprocal of crystallization half time($t_{1/2}^{-1}$) which corresponds to the crystallization rate increased with the degree of supercooling(ΔT); however Avrami exponent did not significantly change with the degree of supercooling(ΔT) and PEO concentration.

Table 1. Gel Melting Temperature and Clearing Temperature of PEO / DMF Gels

PEO Concentration(g/ml)	DSC Tm(℃)	Clearing Temp. on Heating(℃)
0.10	16.8	19
0.20	21.7	23
0.30	23.5	25
0.40	26.5	28
0.50	30.6	32

Table 2. Equilibrium Melting Temperature and Stability Parameter of PEO / DMF Gels

PEO Concentration(g/ml)	Tm°(℃)	ϕ
0.20	28.5	0.31
0.25	29.2	0.32
0.30	29.4	0.30

Table 3. Avrami Exponent(n), Kinetic Rate Constant(k), and the reciprocal of Crystallization Half Time ($t_{1/2}^{-1}$) for PEO / DMF Solutions

PEO Concentration(g/ml)	ΔT(℃)	n	k(min^{-n})	$t_{1/2}^{-1}$(min)
0.20	8.8	2.00	0.17	0.50
	10.6	1.95	0.64	0.96
	12.4	2.22	1.25	1.31
0.25	9.2	2.06	0.09	0.38
	11.1	2.30	0.39	0.78
	12.9	2.23	1.44	1.39