NOTE

Miscibility of Chitosan–Hydroxyethylcellulose Blends in Aqueous Acetic Acid Solutions at 35°C

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ABSTRACT: The miscibility of blends of chitosan and hydroxyethylcellulose in a 2% acetic acid solution was studied by viscometry, densitometry, and refractometry at 35°C. The data suggest that the blends were completely miscible in all proportions. Further, the membranes were fabricated from concentrated blend solutions. The solid-state compatibility of the blends was confirmed by scanning electron microscopy. © 2005 Wiley Periodicals, Inc. J Appl Polym Sci 96: 1996–1998, 2005

Key words: blends; viscosity; refractive index; miscibility

INTRODUCTION

Polymer blend miscibility and compatibility has been extensively studied.[1–7] In this study, blend miscibility was examined by viscometry, densimetry, and refractometry with solutions of chitosan (CS) and hydroxyethylcellulose (HEC) prepared in 2% acetic acid (v/v). These membranes have importance in pervaporation separation studies on water–organic mixtures.[8–12] Blend membrane compatibility was further confirmed by scanning electron microscopy.

EXPERIMENTAL

Materials

CS, a medium molecular weight polymer, was purchased from Aldrich Chemicals (Milwaukee, WI). HEC, a low-viscosity-grade sample, was purchased from Polysciences (Mumbai, India). Other chemicals were analytical-reagent-grade samples purchased from S. D. Fine Chemicals (Mumbai, India). Double-distilled water was used throughout the study.

Preparation of the blend solutions

Stock solutions of CS and HEC at 0.5 mass % were prepared in 100 mL of aqueous acetic acid in five different mass percentage ratios of CS and HEC. The blend solutions were prepared by mixing 20/80, 40/60, 50/50, 60/40, and 80/20 ratios of the CS and HEC polymers, respectively. From these blend solutions, 0.05, 0.1, 0.15, 0.2, and 0.25 g/dL solutions were prepared volumetrically in 2% acetic acid.

Methods

The densities of the CS and HEC solutions and their blends were measured with a high-precision vibrating-tube digital density meter (Anton Paar, DMA model 4500/5000, Graz, Austria) as described earlier.[12] The accuracy in density value was ± 0.00001 g/cm^3 at a temperature control of ± 0.01°C.

The dilute solution viscosities of CS and HEC and their blends were measured at 35°C with a Scott-Gerate Viscometer (model AVS 350, Hofheim, Germany) as described earlier.[12] The uncertainty in the viscosity was ± 0.001 mPa s.

The refractive index for the sodium D line was measured by a thermostatically controlled digital Abbe refractometer (Atago, model 3T, Tokyo) as described earlier.[12] The uncertainty in the refractive index was ± 0.0001 units.

Scanning electron microscopy of the 50:50 CS–HEC blend membrane was performed on a Leica Stereoscan-440 scan-

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TABLE I
Density, Viscosity, and Refractive Index Values for CS, HEC, and Their Blend Solutions at 35°C

Concentration (%)	Pure CS	20% CS	40% CS	50% CS	60% CS	80% CS	Pure HEC
			Absolute viscosity (mPa.s)				
0.05	1.87	0.98	1.15	1.27	1.37	1.59	0.77
0.10	3.36	1.41	1.77	2.02	2.28	2.83	0.83
0.15	4.86	1.76	2.40	2.87	3.19	4.10	0.90
0.20	6.93	2.46	3.26	3.70	4.30	5.31	0.96
0.25	8.34	3.19	4.20	4.85	5.55	6.81	1.05
			Density (g/cm^3)				
0.05	0.99698	0.99693	0.99694	0.99694	0.99696	0.99697	0.99692
0.10	0.99707	0.99702	0.99703	0.99704	0.99705	0.99706	0.99701
0.15	0.9924	0.99715	0.99716	0.99717	0.99719	0.99721	0.99713
0.20	0.99733	0.99727	0.99729	0.99729	0.99730	0.99732	0.99725
0.25	0.99753	0.99740	0.99743	0.99744	0.99747	0.99750	0.99738
			Refractive index				
0.05	1.3324	1.3324	1.3324	1.3324	1.3324	1.3324	1.3324
0.10	1.3325	1.3325	1.3325	1.3325	1.3325	1.3325	1.3325
0.15	1.3326	1.3326	1.3326	1.3326	1.3326	1.3326	1.3326
0.20	1.3327	1.3327	1.3327	1.3327	1.3327	1.3327	1.3327
0.25	1.3328	1.3328	1.3328	1.3328	1.3328	1.3328	1.3328

ning electron microscope equipped with Phoenix energy dispersive analysis of X-rays available at the National Chemical Laboratory, Pune, India (courtesy of Mr. A. B. Gaikwad).

RESULTS AND DISCUSSION

From the measured viscosity values, absolute viscosity was calculated (see in Table I) and plotted versus blend composition (see Fig. 1). Linear variations at all of the concentrations indicated the miscible nature of the CS–HEC blends. The miscibility of the CS–HEC blends was also studied from the plots of density and refractive index versus the composition of the blends, as displayed in Figures 2 and 3, respectively. Linear variations of these properties with blend composition further suggested the miscibility of the CS–HEC blends.

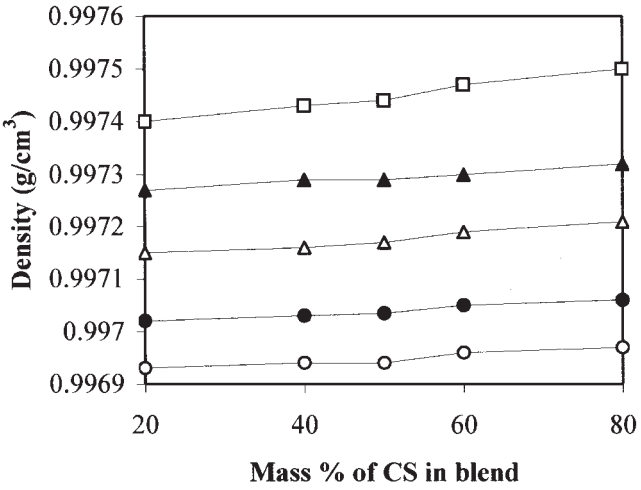

Figure 2 Density versus composition of blend for different concentrations of the blend: (○) 0.05, (●) 0.1, (△) 0.15, (▲) 0.2, and (□) 0.25%.

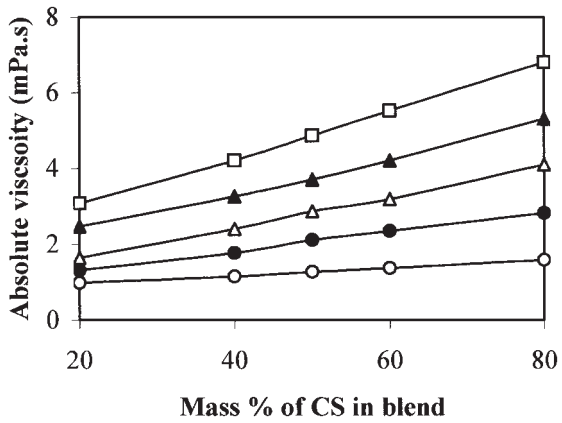

Figure 1 Absolute viscosity versus composition of blend for different concentrations of the blend: (○) 0.05, (●) 0.1, (△) 0.15, (▲) 0.2, and (□) 0.25%.

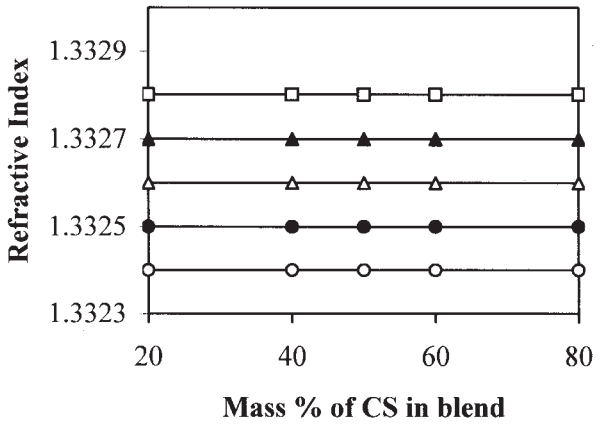

Figure 3 Refractive index versus composition of the blend for different concentrations of the blend: (○) 0.05, (●) 0.1, (△) 0.15, (▲) 0.2, and (□) 0.25%.

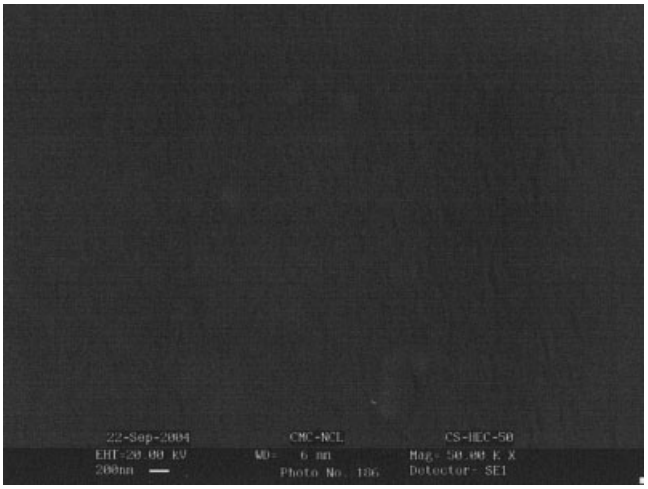

Figure 4 Scanning electron micrograph of the 50:50 CS–HEC blend.

In an effort to quantitatively assess the miscibility of the CS–HEC blends, we prepared the membranes for use in pervaporation separation studies.[10] The scanning electron micrograph of the 50:50 blend of CS and HEC, as displayed in Figure 4, was further proof of the blend miscibility.

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