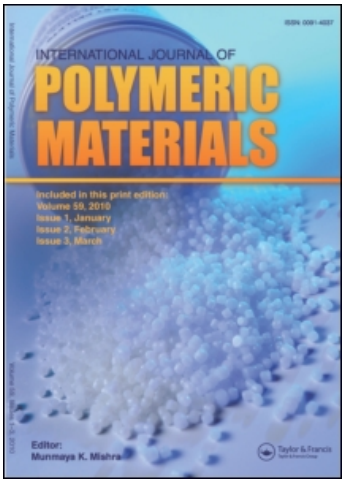

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Miscibility Studies of Poly (vinyl acetate) and Cellulose Acetate

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Miscibility Studies of Poly (vinyl acetate) and Cellulose Acetate

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Polymer blends of poly (vinyl acetate) (PVAc) with cellulose acetate (CA) have been prepared by solution blending, and their miscibility has been investigated by using physical techniques. Viscosity, density, and ultrasonic velocity for blend solutions at different percentages of the blend composition have been measured at 30°C. The results are discussed.

Keywords: cellulose acetate, miscibility, polymer blends, poly (vinyl acetate)

INTRODUCTION

Polymer blends are the physical mixtures of two or more homopolymers, copolymers, and so on. Polymer blends are prepared by many methods and among them solution blending is very simple and rapid. Blending of two or more polymers has become an increasingly important technique for improving the cost–performance ratio of commercial plastics. Recently, many simple and rapid solution techniques have been used for probing the miscibility of polymer blends in solution [1–7]. The study of miscibility behavior of the polymer blends by determining the ultrasonic velocity, viscosity, and density has been taken in the present work. Poly (vinyl acetate) and cellulose acetate were chosen because of their wide range of applications. Both polymers have acetate groups in their structure and due to difference in the main

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chain they greatly differ in physical properties. CA is rigid; it decomposes below its melt processing temperature and it has reasonable toughness and transparency. Plasticizers are used for making of moldable articles to increase the softness, whereas PVAc is soft and shows excessive cold flow.

The present article aims to improve the softness of the CA by blending with PVAc. Before the study, the authors probed the miscibility of CA/PVAc blends by simple physical methods such as viscosity, ultrasonic velocity, and density.

EXPERIMENTAL

The blends of poly(vinyl acetate)/cellulose acetate of different compositions were prepared by solution blending in acetone.

Viscosity Measurements

The relative viscosity of blend solutions for different compositions was determined at a constant temperature of $30 \pm 0.01^{\circ}C$ by using an ubbelohode-suspended level viscometer kept in a constant-temperature water bath.

Ultrasonic Velocity Measurements

Ultrasonic velocity measurements of the PVAc/CA blend solutions of different compositions were carried out by using ultrasonic interferometer maintained at 30°C by circulating water from a thermostat with a thermal stability of $\pm 0.05^{\circ}C$ through the double-wall jacket of the ultrasonic experimental cell [8].

Density Measurements

The densities of the polymer blend of poly (vinyl acetate)/(cellulose acetate) were measured using a specific gravity bottle. To maintain a constant temperature, the specific-gravity bottle with the sample was immersed up to the neck in the thermostated path maintained at 30°C.

RESULTS AND DISCUSSION

Polymer blends of PVAc/CA in acetone with different compositions of 1 wt% solutions were prepared. The relative viscosity, ηrel, for each composition of the polymer blend PVAc/CA was determined by

TABLE 1 Viscosity Measurements of Poly (vinyl acetate)/(Cellulose acetate) Blend

1% Consentation of PVAc: CA	Relative viscosity	Specific viscosity	Reduced viscosity
0:100	3.2266	2.2266	0
20:80	3.3893	2.3893	0.1194
40.60	2.9966	1.9906	0.0497
50:50	2.5533	1.5533	0.0398
60:40	2.4613	1.4613	0.0236
80:20	2.1533	1.1533	0.0144
100:0	1.6666	0.6666	0.6666

viscometer. The relative, specific, reduced viscosities of the polymer/blend solutions for different compositions were calculated by measuring the flow time of different solutions and the values are tabulated in Table 1.

A graph drawn between ηred and percentage composition clearly indicates the polymer blend is immiscible because of the nonlinear variation of reduced viscosity with blend composition.

Ultrasonic Velocities

In the present investigation, ultrasonic velocities for polymer blend solutions of PVAc/CA were calculated by:

$$\mathrm{d} = \mathrm{n}(\lambda/2) \tag{1}$$

where d is the distance moved by the head scale and n is the number of nodes or antinodes, λ is the wavelength.

TABLE 2 Ultrasonic Velocities of Poly (vinyl acetate)/Cellulose acetate) Blend

PVAc/CA	Ultrasonic velocities
0:100	1.13280
20:80	1.1488
40:60	1.81616
50:50	1.152
60:40	1.425
80:20	1.136
100:0	1.623

TABLE 3 Density Measurements of Poly (vinyl acetate)/ Cellulose acetate) Blend

PVAc/CA	Density
0:100	0.8687
20:80	0.8707
40:60	0.8691
50:50	0.8701
60:40	0.8695
80:20	0.8693
100:0	0.8703

From the wavelength (λ), the velocity (v) of ultrasonic waves in the liquid can be calculated using the following formula:

$$V = \lambda \times f \tag{2}$$

where f is the frequency of the crystal in the oscillator.

The PVAc/CA blend compositions and ultrasonic velocities values are tabulated in Table 2.

The relationship in Table 2, between ultrasonic velocity versus percentage of composition clearly indicates that the blend is immiscible because of nonlinear variation of ultrasonic velocity with blend composition.

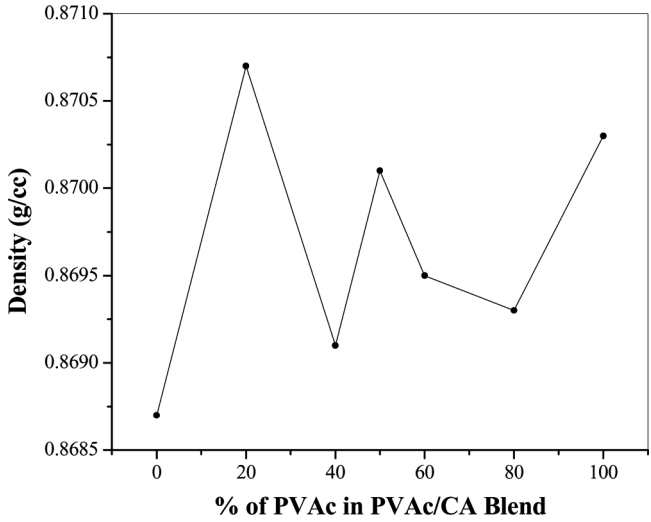

FIGURE 1 Variation of density with composition of PVAc/CA blend.

Density

The relationship between PVAc and CA blend composition and density values is tabulated in Table 3.

A graph drawn between density values and composition of the blend and the graph (Figure 1) indicates a nonlinearity, which confirms the immiscibility of the PVAc/CA blend.

CONCLUSION

In this article, the variation of reduced viscosity, ultrasonic velocity, and density with blend composition is nonlinear, which confirms the blend is immiscible.

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