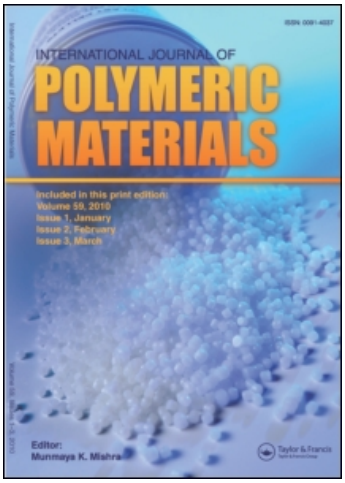

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Immiscibility of Silicone Rubber and Polymethylmethacrylate

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Polymer blends of silicone polymer with polymethylmethacrylate (PMMA) have been prepared by solution blending, and their miscibility has been investigated by using physical techniques like viscosity, refractive index, density and ultrasonic velocity for blend solutions at different percentages of the blend composition. All the measurements are made at 30°C. The results are discussed.

Keywords: miscibility, polymer blends, polymethylmethacrylate (PMMA), silicone polymer

INTRODUCTION

Blending 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 [1–9].

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A study of miscibility behavior of the polymer blends, determining the ultrasonic velocity, viscosity, refractive index and density, has been taken up in the present work.

Silicone polymers do not have carbon as part of the backbone structure, so are an inorganic polymer. Silicone polymers can withstand fairly high temperatures without degradation.

Silicone polymers are water repellent, heat stable and very resistant to chemical attack. They find many uses in oils, greases and rubber-like materials. Silicone oils are very desirable since they do not decompose at high temperature and do not become more viscous. Silicone polymers are very stable and available in liquid, waxy and rubbery forms. These polymers find uses in surface coatings, where water repellency and chemical resistances are of prime concern. Silicone polymers are also used to manufacture laminates, which can withstand fairly high temperatures without degradation.

Lightweight forms are made from silicone resins by using forming agents. Such forms are used in airplanes and missiles. Further, silicone polymers are used as elastomers and can be vulcanized with the help of peroxide initiators. Silicone in the form of powder is used as filler to reinforce rubbers. Such rubbers remain flexible at temperatures as low as -90°C and as high as $+150^{\circ}$C.

MATERIALS

PMMA is a colorless transparent plastic with an excellent outdoor life period and good strength. It is amorphous by nature, owing to the presence of bulky side groups in the molecules. It is resistant to many chemicals but soluble in organic solvents such as ketones, chlorinated hydrocarbons and esters. Optical clarity is the main feature of this plastic. In many applications, it is an excellent substitute for glass; it has good mechanical properties too. However, compared to glass, it has poor scratch resistance. PMMA is used to make attractive signboards and durable lenses for automobile lighting. It is also used in buildings for decorative purposes. PMMA has carbon as part of the backbone structure, so it is an organic polymer.

EXPERIMENTAL METHODS

Blends of silicone polymers and PMMA of different compositions were prepared by solution blending in toluene. The blends, of different compositions, were prepared by mixing two solutions of the polymers in a single solvent. All measurements were conducted at 30°C.

Viscosity Measurements

The relative viscosity of blend solutions of different compositions were determined using an Ubbelohde Suspended Level Viscometer (up to the neck level) immersed in a constant temperature water bath fitted with a glass window.

Ultrasonic Velocity Measurements

Ultrasonic velocity measurements of the silicone/PMMA blend solutions of different compositions were carried out by using Ultrasonic Interferometer (M/S Mittal Enterprises, New Delhi) through the double wall jacket of the Ultrasonic experimental cell.

Density Measurements

The densities of polymer blends of silicone/PMMA were measured using a specific gravity bottle maintained at 30°C.

Refractive Index Measurements

The refractive indices of the blend solutions were measured with an Abbe's Refractometer kept at 30°C.

RESULTS AND DISCUSSION

Polymer blends of silicone/PMMA in toluene with different compositions of 1% wt solutions were prepared. The relative viscosity η_{rel} for each composition of the silicone/PMMA blend was determined by viscometer. The relative, specific and reduced viscosities of the solutions for different compositions were calculated by measuring the flow time of different solutions. The values are tabulated in Table 1.

TABLE 1 Viscosity Measurements of Silicone/PMMA Blend

Concentration of silicone/PMMA	Relative viscosity	Specific viscosity	Reduced viscosity
0.0:1.0	1.2709082	0.2709082	0.0000
0.2:0.8	1.2474278	0.2474278	1.2370
0.4:0.6	1.2008457	0.2008457	0.5020
0.5:0.5	1.1677081	0.1677081	0.3354
0.6:0.4	1.127501	0.1275010	0.2125
0.8:0.2	1.0707567	0.0707567	0.0883
1.0:0.0	1.029098	0.029098	0.2709

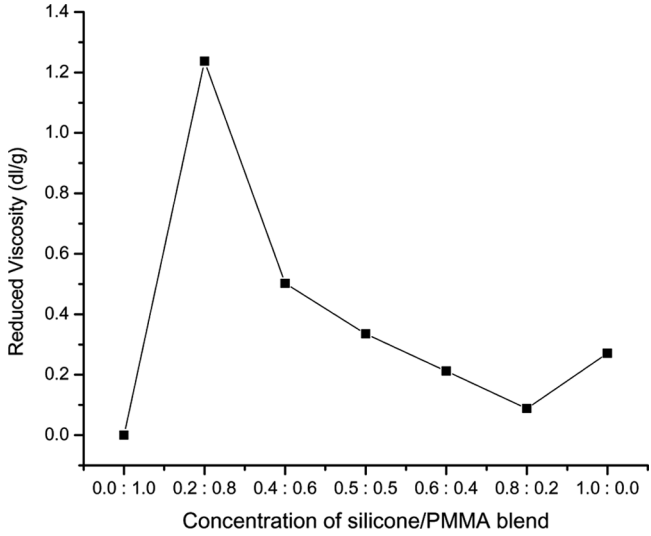

FIGURE 1 Reduced viscosity with composition of silicone/PMMA blend.

A graph drawn between reduced viscosity η_{red} on the Y-axis and percentage of composition on X-axis, shown in Figure 1, clearly indicates that polymer blend is immiscible because of non-linear variation of reduced viscosity with blend composition.

Ultrasonic Velocity

In the present investigation, ultrasonic velocities for solutions of silicone/PMMA were calculated by Eq. (1)

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

TABLE 2 Ultrasonic Velocities of Silicone/PMMA Blend

Concentration of silicone/PMMA	Ultrasonic velocity (m/sec)
0.0:1.0	1.28240
0.2:0.8	1.27328
0.4:0.6	1.28384
0.5:0.5	1.27616
0.6:0.4	1.27728
0.8:0.2	1.27936
1.0:0.0	1.27100

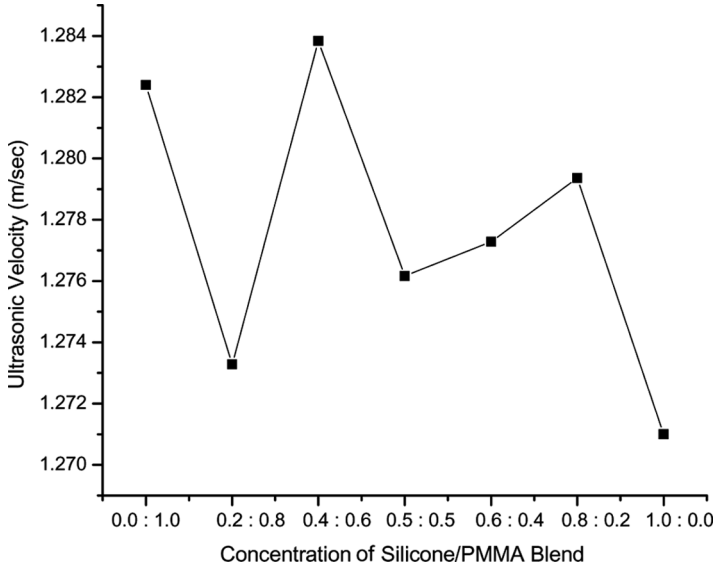

FIGURE 2 Ultrasonic velocity values with composition of silicone/PMMA blend.

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

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

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

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

The silicone/PMMA blend compositions and ultrasonic velocities values are tabulated in Table 2.

TABLE 3 Density Values of Silicone/PMMA Blend

Concentration of silicone/PMMA	Density (g/cc)
0.0:1.0	0.848380
0.2:0.8	0.848456
0.4:0.6	0.848236
0.5:0.5	0.847508
0.6:0.4	0.847176
0.8:0.2	0.846516
1.0:0.0	0.847492

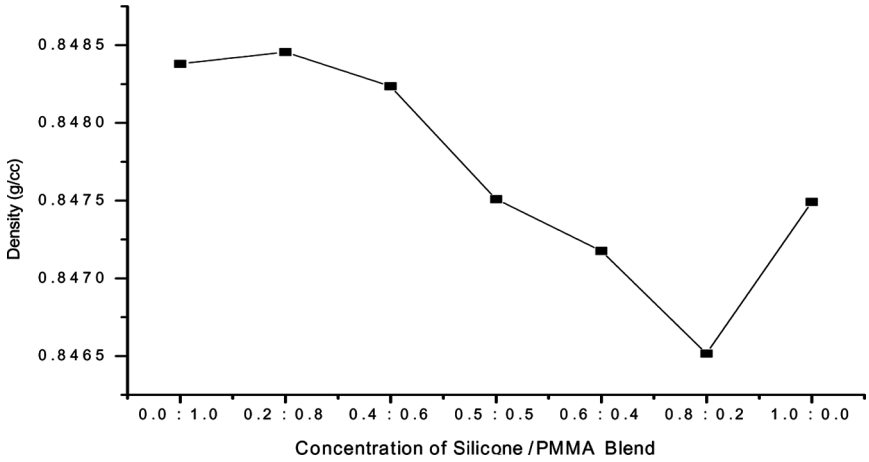

FIGURE 3 Density values with composition of silicone/PMMA blend.

A graph (Figure 2) was drawn of ultrasonic velocity versus percentage of compositions. Figure 2 clearly indicates that the blend is immiscible because of nonlinearity of the curve.

Density

In order to evaluate the miscibility behavior of silicone/PMMA blend composition, density values are tabulated in Table 3.

A graph drawn between density values and composition of the blend (Figure 3) indicates a nonlinear behavior and confirms immiscibility of the silicone/PMMA blend.

TABLE 4 Refractive Index Values of Silicone/PMMA Blend

Concentration of silicone/PMMA	Refractive index
0.0:1.0	1.4875
0.2:0.8	1.4865
0.4:0.6	1.487
0.5:0.5	1.4875
0.6:0.4	1.4865
0.8:0.2	1.486
1.0:0.0	1.4855

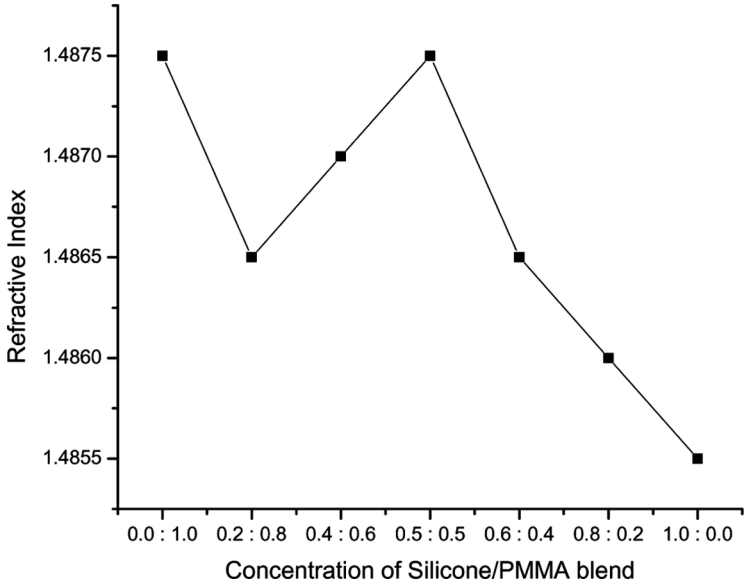

FIGURE 4 Refractive index values with composition of silicone/PMMA blend.

Refractive Index

The refractive index values of silicone/PMMA blend composition are given in Table 4.

A graph was drawn between refractive index values and composition of the blend. The nonlinear behavior of the graph (Figure 4) confirms the immiscibility of the silicone/PMMA blend.

CONCLUSION

The variations of reduced viscosity, ultrasonic velocity, refractive index and density with blend composition are nonlinear and confirm that the blend is immiscible.

REFERENCES

[1] Chee, K. K., *Eur. Polym. J.* **26**, 423 (1990).
[2] Sun, Z., Wang, W., and Fung, Z., *Eur. Polym. J.* **28**, 1259 (1995).
[3] Danait, A. and Dishpande, D. D., *Eur. Polym. J.* **31**, 1221 (1995).
[4] Biswas, B., *Polymer* **32**, 1095 (1991).
[5] Kulshrestha, A. K., Singh, B. P., and Sharma, Y. N., *Eur. Polym. J.* **24**, 33 (1998).
[6] John, K., Jayasimha Reddy, G., and Venkata Naidu, S., *Int. J. Polym. Anal. Char.* **8**, 295 (2003).

[7] John, K., Jayasimha Reddy, G., and Venkata Naidu, S., *J. Acous. Soc. Ind.* **29**, 225 (2001).
[8] Varada Rajulu, A. and Mabusab, P., *Eur. Polym. J.* **32**, 267 (1996). Miscibility of Poly (vinyl acetate) and Cellulose Acetate 1175.
[9] Mohan Reddy, M., Jayasimha Reddy, G., and Venkata Naidu, S., Miscibility Studies of Poly(Vinyl acetate) and Cellulose Acetate, *Inter. J. Polym. Mater*. **55**, 1171 (2006).