

Studies on Binary and Ternary Blends of Polypropylene with ABS and LDPE. I. Melt Rheological Behavior

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Synopsis

Studies are presented on melt rheological properties of binary blend of polypropylene (PP) and acrylonitrile–butadiene–styrene terpolymer (ABS), and ternary blend of PP, ABS, and low-density polyethylene (LDPE). Data obtained in capillary rheometer are presented to describe the effect of blending ratio, shear stress, and shear rate on flow properties, melt viscosity, and melt elasticity. At a blend composition corresponding to 10 wt % ABS content, both binary and ternary blends show maximum in melt viscosity accompanied by minimum in melt elasticity. Pseudoplasticity of the melt decreases with increasing ABS content. In ternary blends, LDPE facilitates the flow at low LDPE contents and obstructs the flow at high LDPE contents. Scanning electron microscopic studies are also presented to illustrate the state of dispersion and its variation with blend composition.

INTRODUCTION

Although isotactic polypropylene (PP) itself is a very useful thermoplastic for a wide range of applications, its scope of application could be further increased by blending it with other polymers. Blends of PP have been studied with a large number of polymers including elastomers,^{1–20} polyethylene,^{16–27} and various other crystalline and amorphous thermoplastics such as poly(ethylene terephthalate),²⁸ polycarbonate,²⁹ polystyrene,^{29–31} etc. However, blends of PP with acrylonitrile–butadiene–styrene terpolymer (ABS) seem to have been scantily studied after the initial studies published by Markin and Williams³² and reported in patents by other authors.^{33–37} The three components of ABS impart to this terpolymer a combination of properties, which might be quite useful for blending with PP. The butadiene or combined butadiene–styrene domains improve impact resistance and the acrylonitrile sequences may improve bonding with the matrix polymer, resulting in improvement of other mechanical and physical properties of the blend. Role of elastomer domains, already recognized^{1,4,38} in the improvement of melt processing behavior of PP/elastomer blends, is interesting to examine in case of PP/ABS blend.

In the present work we have undertaken a study of PP/ABS blend with PP as major component and ABS content varying from 5 to 30 wt %. In addition, we have also studied a ternary blend consisting of PP, ABS, and LDPE (low density polyethylene) with a view to explore (i) the effect of dilution with a low cost material on the properties of PP/ABS blend and (ii) the role of

LDPE in the interface properties. This article presents the study of the rheological properties in the molten state of these binary and ternary blends, while the subsequent article³⁹ will deal with solid state structure and properties of these blends.

EXPERIMENTAL

Materials

The three polymers used in this study, PP, ABS, and LDPE, were the commercially available injection molding grade materials. PP (grade: Koylene-M3030, melt flow index 3.0) and LDPE (grade: Indothene-22FA002, melt flow index 0.2) were the products of Indian Petrochemicals Corporation Ltd. Baroda and ABS (A:B:S being 16:17:67) was the product of Polychem Ltd., Bombay.

Blend Preparation

Binary blend of PP and ABS was prepared by melt-mixing the two polymers in a Betol-1820 single-screw extruder at 40 rpm screw speed and 205, 210, 215, and 215°C temperatures of the three zones and the die.

The ternary blend of PP, ABS, and LDPE was prepared by a two-step mixing in the extruder under the above-stated conditions. The first step of mixing involved making of a 50:50 blend of ABS and LDPE, while the second step involved the mixing of this (ABS/LDPE) binary blend with PP in varying blending ratios, to obtain PP/(ABS/LDPE) ternary blend. The two-step mixing procedure was adopted with a view to improve chances of location of LDPE at the interface boundaries of ABS domains in the ternary blend.

Binary blends with ABS content 5, 10, 20, and 30 wt % and ternary blend with total inclusion content 5, 10, 20, and 30 wt % (which corresponds to 2.5, 5, 10, and 15 wt % ABS content, respectively) were prepared. Note that in the subsequent discussion the blend composition of ternary blend will be referred to in terms of either (i) ABS content of the total ternary blend or (ii) blending ratio in terms of the two components, PP as one and (ABS/LDPE) as the other.

Melt-Rheological Measurements

Melt-rheological measurements were made, at a fixed temperature 200°C, on a capillary rheometer (Koka Flow Tester of Shimadzu Seisakushi Ltd., Japan). Capillary dies of circular cross section (diameter 0.5 mm and lengths varying from 1.5 to 15 mm) and flat at the entrance region were used.

Scanning Electron Microscopy

Scanning electron micrographs on the impact-fractured surfaces of the blends were recorded on a Cambridge Stereoscan scanning electron microscope (Model S4-10).

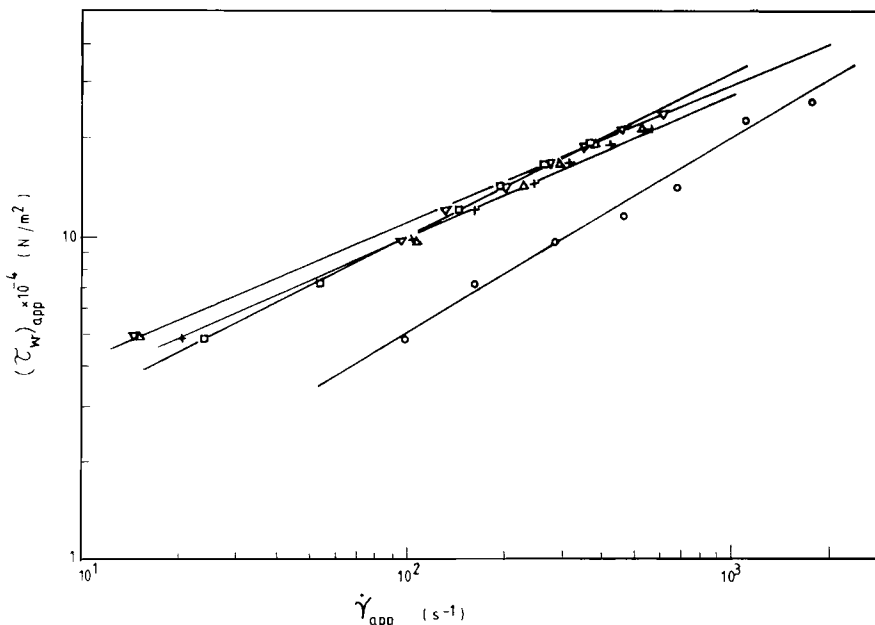


Fig. 1. Apparent shear stress at wall, $(\tau_w)_{app}$, as a function of apparent shear rate $\dot{\gamma}_{app}$ for PP/ABS binary blend at 200°C and $L/R = 10$, at various ABS contents (wt %): (○) 0; (△) 5; (□) 10; (+) 20; (∇) 30.

RESULTS AND DISCUSSION

Melt Rheology of Binary Blend PP/ABS

Flow Curves

From volumetric flow rates at various applied pressures, values of apparent shear stress at wall, $(\tau_w)_{app}$, and apparent shear rate $\dot{\gamma}_{app}$ were calculated using the following expressions⁴⁰

$$(\tau_w)_{app} = \Delta P/2(L/R) \tag{1}$$

$$\dot{\gamma}_{app} = 4Q/\pi R^3 \tag{2}$$

where ΔP is pressure difference between entrance and exit regions of the capillary die, Q is volumetric flow rate, and L and R are respectively the length and radius of the die.

From the $\log (\tau_w)_{app}$ vs. $\log \dot{\gamma}_{app}$ plots (shown in Fig. 1) values of power law exponent n were calculated in accordance with the following power law:

$$(\tau_w)_{app} = K(\dot{\gamma}_{app})^n \tag{3}$$

TABLE I
Value of Power-Law Exponent for PP/ABS Blend

ABS content (wt %)	n [eq. (3)]	n' [eq. (6)]
0	0.63	0.55
5	0.59	0.52
10	0.57	0.52
20	0.56	0.48
30	0.53	0.43
100	0.56	0.51

where K is a constant. Values of n , shown in Table I, are much smaller than unity, implying a strong pseudoplastic character of the melt of these binary blends. A systematic decrease of n from 0.6 to 0.5 with increasing ABS content indicates the role of ABS in increasing the pseudoplasticity of PP melt.

Rabinowitsch correction was applied using values of n determined from eq. (3), to obtain true shear rate $\dot{\gamma}$, according to the following expression⁴⁰:

$$\dot{\gamma} = [(3n + 1)/4n] \dot{\gamma}_{\text{app}} \quad (4)$$

Similarly, true shear stress at wall τ_w was calculated by applying Bagley correction according to the following expression⁴⁰:

$$\tau_w = \frac{\Delta P}{2[(L/R) + e]} \quad (5)$$

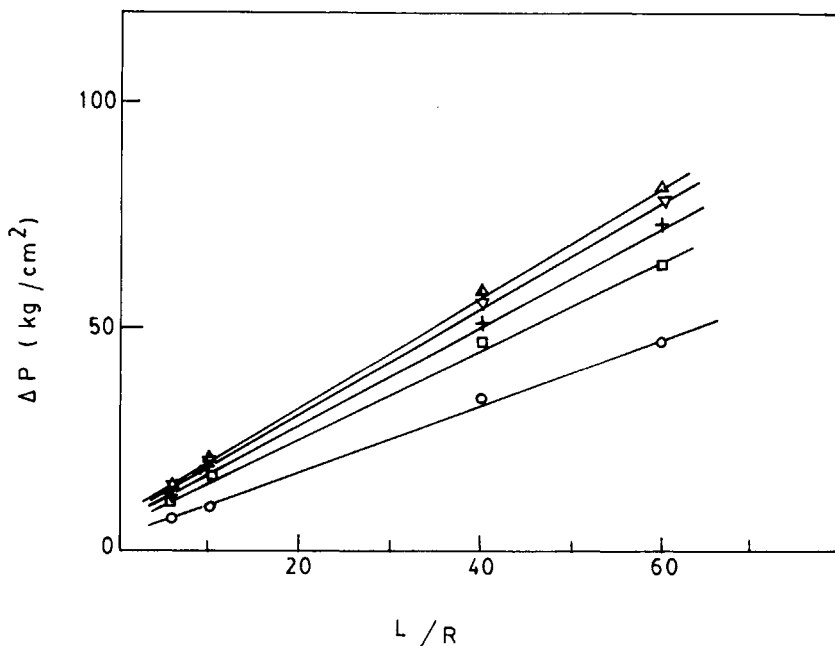


Fig. 2. Variation of entrance-exit pressure drop ΔP with L/R ratio of the capillary for PP/ABS blend at various ABS contents (wt %): (○) 0; (Δ) 5; (▽) 10; (□) 20; (+) 30.

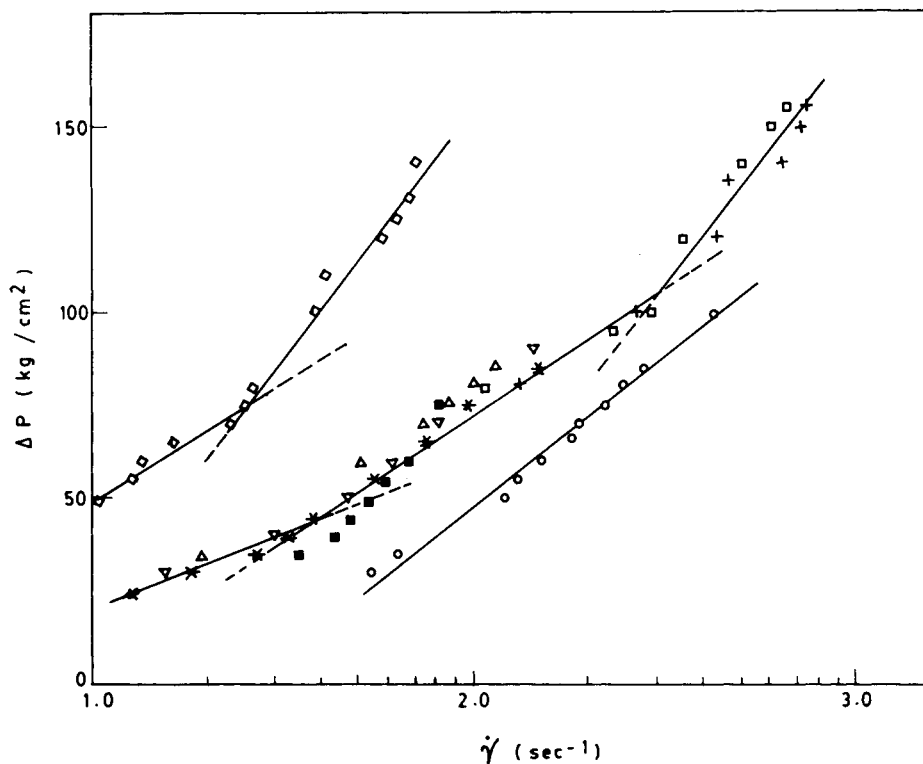


Fig. 3. Variation of entrance-exit pressure drop ΔP with shear rate $\dot{\gamma}$ at 200°C ($L/R = 60$) for PP, ABS, and PP/ABS blend at various ABS contents (wt %): (Δ) 5; (∇) 10; (\square) 20; (+) 30; (*) 40; (\blacksquare) 50; (\circ) PP; (\diamond) ABS.

where the end-correction term e was evaluated from the flow data recorded with four different dies of L/R varying from 6 to 60. Bagley plots, ΔP as function of L/R , for PP and PP/ABS binary blend at various compositions, shown in Figure 2, are quite linear. This linearity of Bagley plot confirms the absence of slippage at the capillary wall and at the interphase boundaries, since the slippage is believed⁴¹ to cause curvature in Bagley plot.

Variation of ΔP with $\log \dot{\gamma}$, shown in Figure 3, is quite linear for PP over the entire range of measurements, whereas for ABS a change of slope occurs at a shear rate 25 s^{-1} . For the PP/ABS binary blend the data points in the studied range are clustered around three linear portions intersecting at shear rates 40 and 300 s^{-1} . Increase of slope implies greater difficulty to flow or higher viscosity, due to the occurrence of elongational flow. The observed increase of slope with the increase of shear rate supports this view, since the elongational flow predominates at higher shear rates. The two-step variation of slope in the case of the binary blend might correspond to either (i) the onset of elongational flow of the two components (PP and ABS) of the blend or (ii) the elongational flow of the matrix and the deformation and breaking up of the dispersed droplets.

As a function of blend composition at a constant shear rate, ΔP varies for PP/ABS binary blend as shown in Figure 4. Initially up to 10 wt % ABS content ΔP rises sharply and then it drops down and finally again rises with

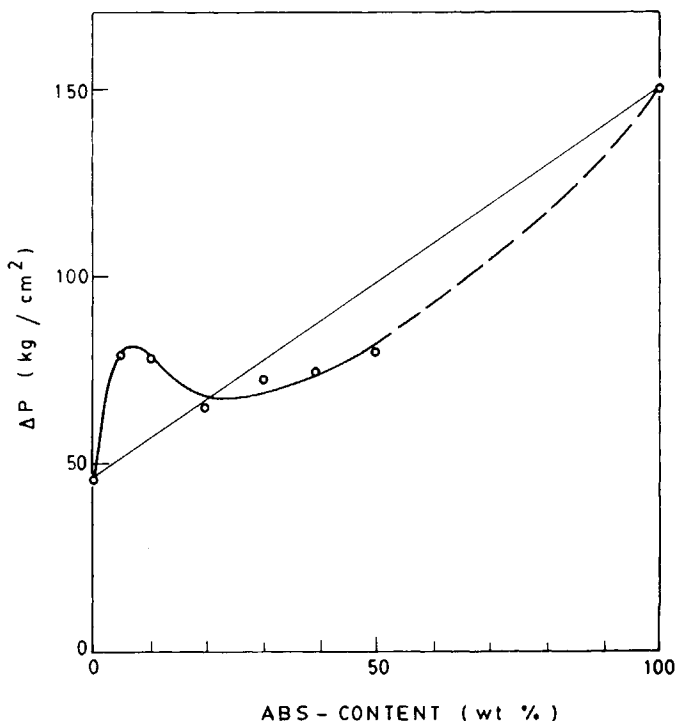


Fig. 4. Variation of entrance-exit pressure drop ΔP with blend composition for PP/ABS binary blend at shear rate = 10^2 s^{-1} , temperature 200°C , $L/R = 60$.

increasing ABS content beyond 20 wt %. Such a composition dependence of ΔP may be related to the variation of dispersed phase morphology, which will be discussed subsequently.

Flow curves in terms of corrected values of shear stress and shear rate are presented in Figure 5 for the PP/ABS binary blend at various blending ratios. Data on neat PP and ABS resins are also included in Figure 5 to illustrate the behavior of the blend vis-à-vis its two components. The measurements on neat ABS were made with only one capillary ($L/R = 60$); hence only Rabinowitsch correction was applied, while Bagley correction was negligible at the high L/R used. Viscosity of ABS is higher than that of the matrix PP: at shear rate $\dot{\gamma} = 10^2 \text{ s}^{-1}$, $\eta(\text{ABS}) = 1200 \text{ N s/m}^2$, and $\eta(\text{PP}) = 330 \text{ N s/m}^2$. The power law exponent of ABS ($n = 0.51$) is slightly lower than that of PP. Flow curves for the binary blend at various compositions lie in-between the flow curves of matrix PP and the dispersed phase ABS.

Variation of viscosity with blend composition, shown in Figure 6, is nonlinear with "negative deviation" in case of the binary blend and "positive deviation" in case of the ternary blend with respect to linear extrapolation between PP and ABS extremes. The observed negative deviation for the binary blend supports the belief⁴² that higher viscosity of dispersed phase than the matrix results in negative deviation. However, the two data points at low blending ratios are on the positive deviation side, which might be the effect of the very small size of dispersed droplets. More remarkable is the

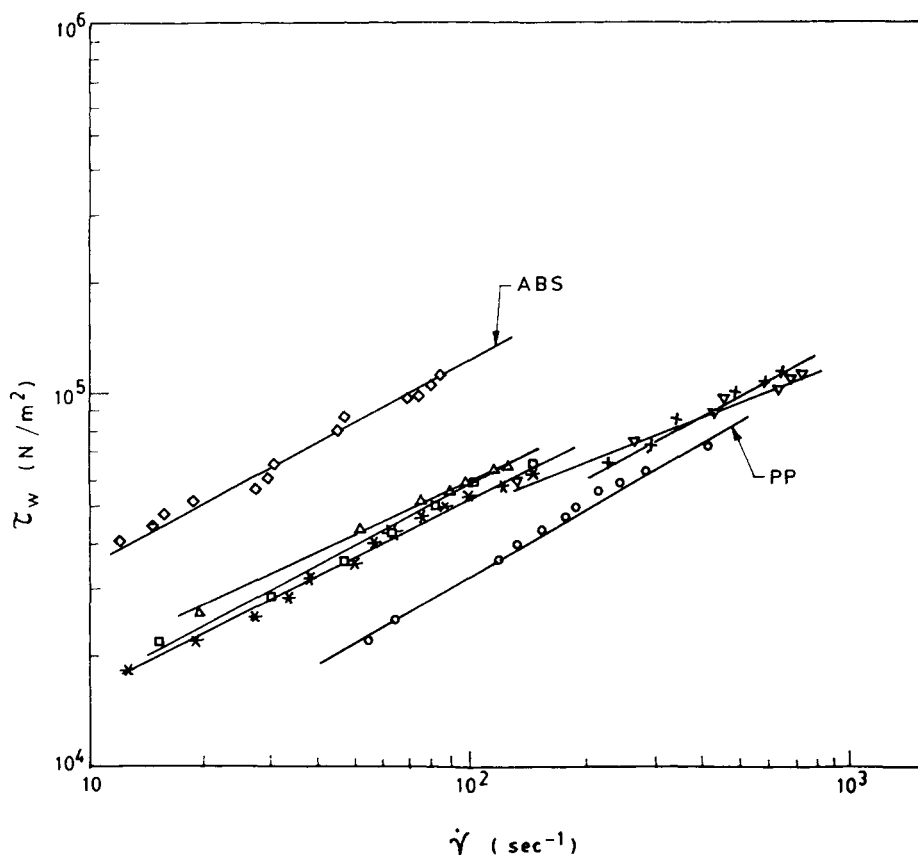


Fig. 5. Flow curves, in terms of shear stress τ_w , as function of shear rate $\dot{\gamma}$, for PP/ABS binary blend and the unblended components PP, ABS at 200°C, at various ABS contents (wt %): (Δ) 5; (\square) 10; (+) 20; (∇) 30; (*) 40; and the unblended components: (\circ) PP; (\diamond) ABS.

behavior of the ternary blend, which shows positive deviation in contrast to the binary blend. This indicates stronger interphase interaction in the ternary blend than in the binary blend as per Utracki's⁴³ distinction of positive and negative deviation blends.

The power law fitting these flow curves (Fig. 5) may be written as follows:

$$\tau_w = K' \dot{\gamma}^{n'} \quad (6)$$

where K' and n' are used to distinguish them from K and n of eq. (3). These corrected values of power law exponent n' shown in the last column of Table I are slightly smaller than the values of n corresponding to eq. (3). The present value of n' for unblended PP is slightly higher than the value 0.48 of power law index of PP reported by Markin and Williams.³² Furthermore, the decrease of n' with increasing ABS content of the blend is quite systematic and similar to that seen in case of n , thus reinforcing the point about the role of ABS in increasing pseudoplasticity of PP.

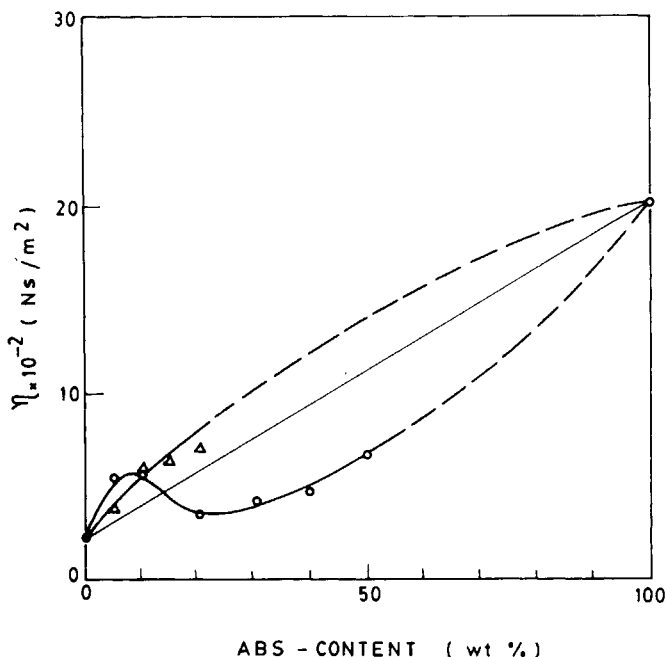


Fig. 6. Comparison of positive and negative deviation characteristics of the PP/ABS binary and PP/(ABS/LDPE) ternary blend with respect to linear extrapolation between PP and ABS extremes: (O) binary blend; (Δ) ternary blend.

Melt Viscosity

Melt viscosity data of the PP/ABS binary blend are presented in Figures 7–9 as the variations of melt viscosity η ($\eta = \tau_w/\dot{\gamma}$) with shear stress, shear rate, and blend composition. At any given shear stress (or shear rate), melt viscosity is the lowest at 0% ABS content (i.e., unblended PP), and increases in a large step at 5% ABS content. Thereafter its variation with ABS content becomes quite small.

Decrease of melt viscosity with increasing shear stress or shear rate (Figs. 7 and 8) is quite linear for all the compositions of the binary blend. These linear variations are consistent with the following power law relationships:

$$\eta = A\tau_w^a \quad (7)$$

$$\eta = B\dot{\gamma}^b \quad (8)$$

The values of exponents a and b are given in Table II. These values of a and b are consistent with their relationships with power law exponent n' used in eq. (6), viz., $a = (n' - 1)/n'$ and $b = (n' - 1)$. The observed systematic decrease of a and b with increasing ABS content of the blend indicates a positive role of ABS domains in the melt flow of the PP/ABS blend.

Variations of melt viscosity as a function of blend composition, with shear stress as parameter, is shown in Figure 9. Initial addition of 5–10 wt % ABS produces an increase of melt viscosity of PP by a factor of 2.5–3, and

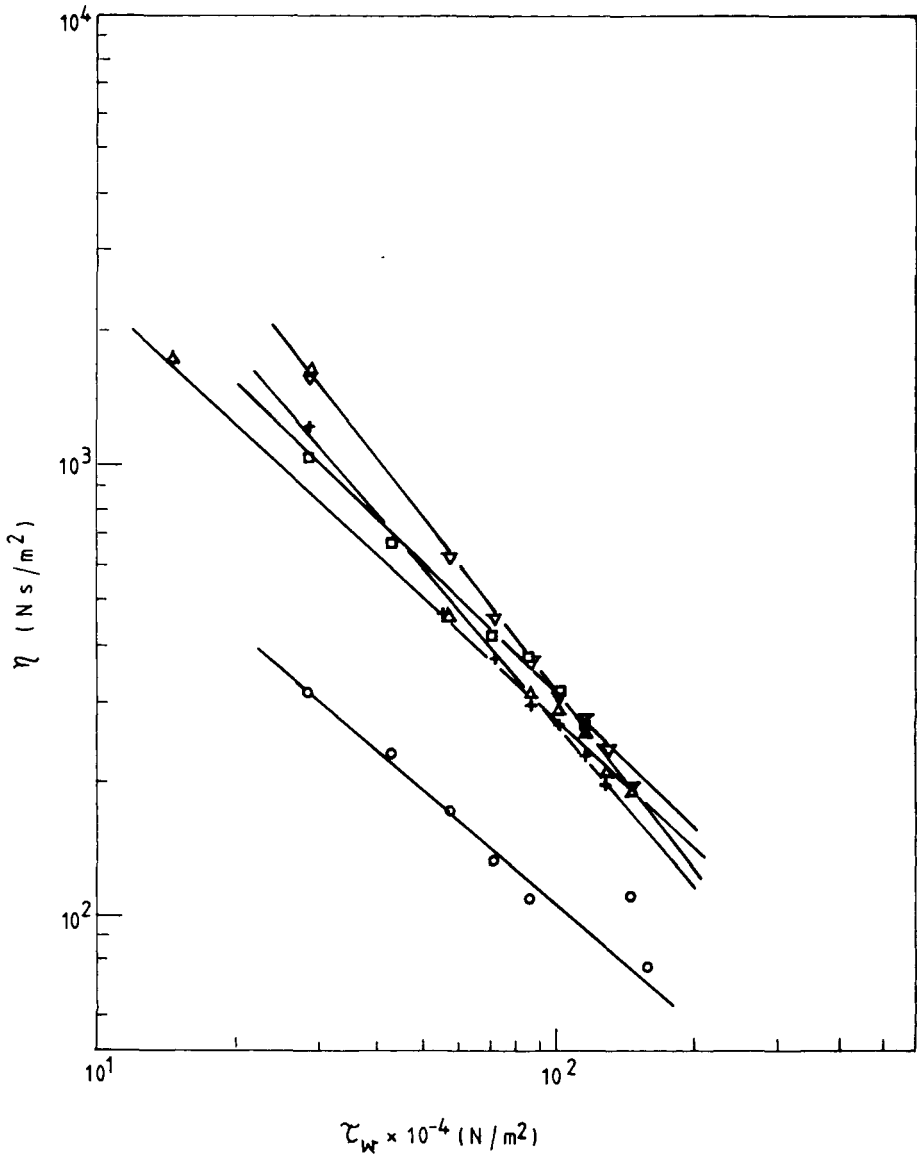


Fig. 7. Variation of melt viscosity η with shear stress τ_w at 200°C for PP/ABS binary blend at various ABS contents (wt %): (O) 0; (Δ) 5; (\square) 10; (+) 20; (∇) 30.

thereafter the melt viscosity decreases slightly and then again increases with increasing ABS content of the blend. The overall shape of the curve shows a maximum around 10 wt % ABS content and a minimum around 20 wt % ABS; sharpness of these maxima and minima decreases with increasing shear stress (Fig. 9). This seems to be an effect of two-phase flow in which the flow properties are influenced by the size and size-distribution of the dispersed phase domains,³⁰ and the effect is more pronounced at smaller shear stress, due to interaction among the dispersed phase domains.⁴⁴

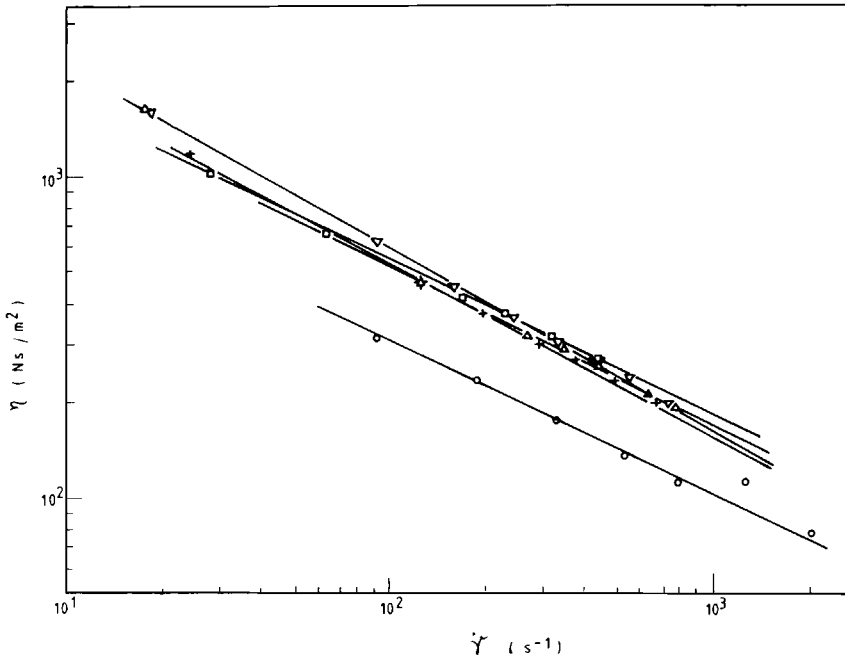


Fig. 8. Variation on melt viscosity η with shear rate $\dot{\gamma}$ at 200°C for PP/ABS binary blend at various ABS contents (wt %): (○) 0; (△) 5; (□) 10; (+) 20; (▽) 30.

Melt Elasticity

Elasticity of the melt results in expansion of the polymer fluid on its exit from the die. The extrudate–swell ratio D_i/D , where D_i and D are diameters of the extrudate and the die, respectively, is a direct measure of melt elasticity. Extrudate swelling of the two-phase blends is composed of two parts: (a) matrix swell and (b) form recovery of dispersed drops. Bogue and White suggested^{44,45} use of the parameter recoverable shear strain γ_R for describing and distinguishing the fluid elasticity of different viscoelastic fluids as function of shear stress. γ_R was calculated from the expression⁴⁰

$$\gamma_R = 2 \left[(D_i/D)^6 - 2 \right]^{1/2} \quad (9)$$

γ_R increases with increasing shear stress as shown in Figure 10. Unblended PP has the highest value of γ_R , which decreases substantially on blending with ABS. This indicates poorer form recoverability of ABS droplets dispersed in the PP matrix. These droplets may absorb a part of the strain energy of the surrounding matrix and in turn account for smaller values of γ_R of the blend in comparison to pure PP. The decrease of γ_R with increasing ABS content further strengthens this view. This reduction of melt elasticity of PP on blending with ABS is a useful gain in property relevant to pro-

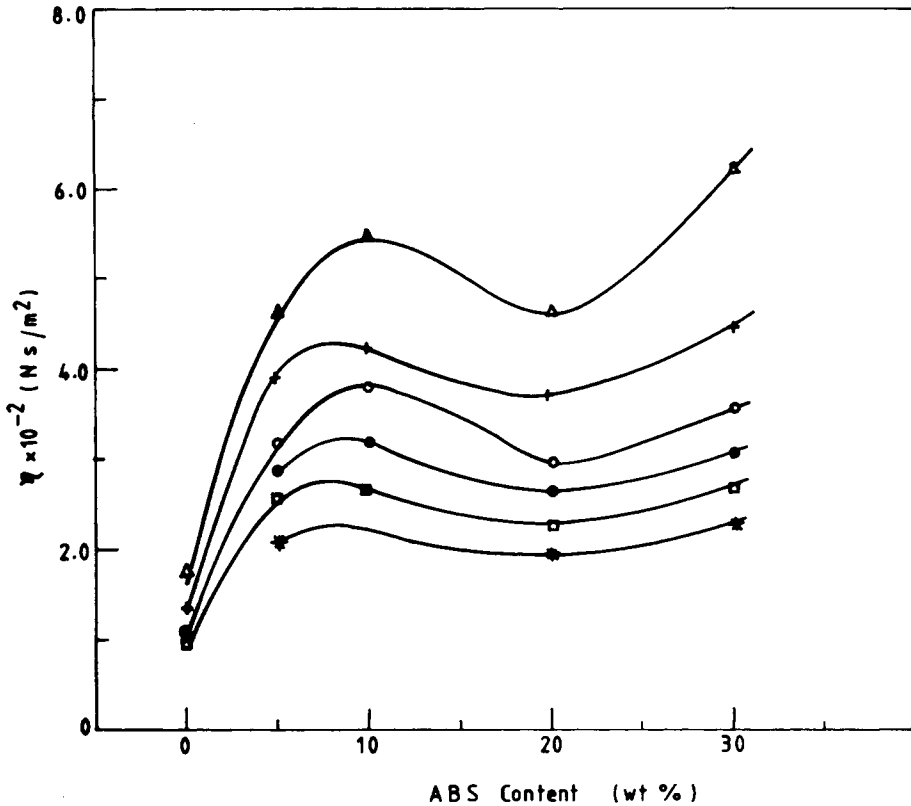


Fig. 9. Variation of melt viscosity η with blend composition at 200°C for PP/ABS binary blend at various shear stresses (N/m²): (Δ) 5.77×10^4 ; (+) 7.21×10^4 ; (\circ) 8.65×10^4 ; (\bullet) 1.01×10^5 ; (\square) 1.15×10^5 ; ($*$) 1.29×10^5 .

TABLE II
Values of Exponents a and b of Eqs. (7) and (8) for PP/ABS Blend

ABS content (wt %)	a	b
0	-0.85	-0.84
5	-0.91	-0.49
10	-0.99	-0.49
20	-1.20	-0.54
30	-1.30	-0.57
100	-0.96	-0.49

cessing, since extrudate distortion tendency reduces with decreasing melt elasticity,^{4, 40, 46, 47} thus enabling the processing at higher shear rates without loss of surface smoothness of the product.

Rate of increase of γ_R with τ_w , though identical for all blend compositions at higher τ_w ($> 5.85 \times 10^4$ N/m²), depends considerably on ABS content at smaller shear stress ($< 5.85 \times 10^4$ N/m²), γ_R increases more sharply for unblended PP and the blend with

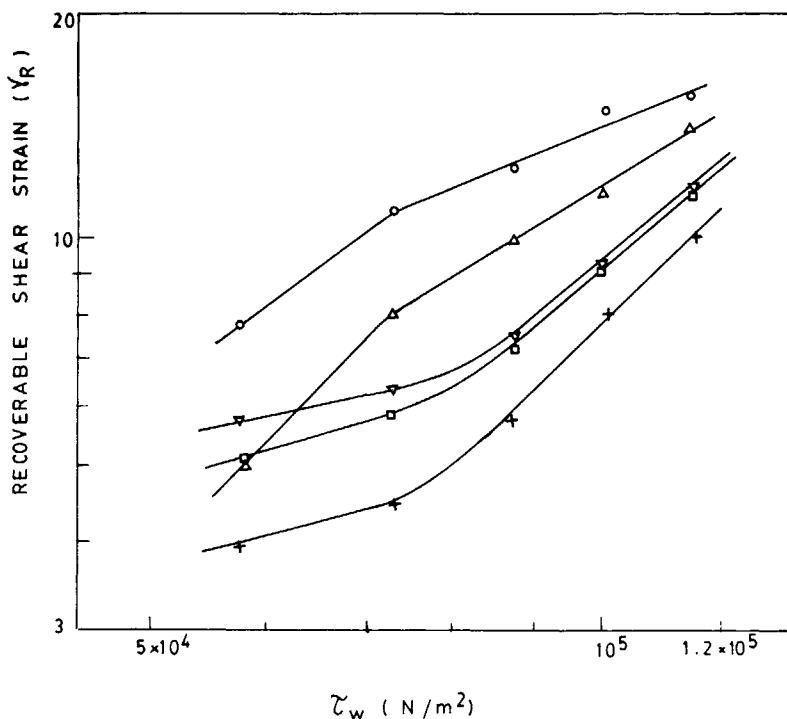


Fig. 10. Variation of recoverable shear strain γ_R with shear stress τ_w at 200°C for PP/ABS binary blend at various ABS contents (wt %): (○) 0; (△) 5; (▽) 10; (□) 20; (+) 30.

lowest ABS content (5 wt %) than the blend at higher ABS content. This is due to smaller absorption of strain energy by the small ABS droplets at the lowest ABS content.

As a function of blend composition the recoverable shear strain γ_R varies in a nonlinear manner, as shown in Figure 11. These variations show minima and maxima at the same compositions of the blend where melt viscosity (Fig. 9) showed maxima and minima (respectively). The maxima and minima are less prominent and the effect of shear stress on them is less distinguishable in melt elasticity than in the case of melt viscosity.

These complementary effects, i.e., the occurrence of minimum in melt elasticity and a maximum in melt viscosity (and vice versa) at identical ABS contents, indicate an active role of the dispersed phase (i.e., ABS) domains on the properties of the melt. In the flow of two-phase polymer blends, such a behavior is believed⁴⁴ to be partly due to interfacial tension and partly due to hydrodynamic effects such as deformability and size of suspended droplets.

As will be shown in a subsequent section on electron microscopy of these blends, the size of the dispersed phase domains varies with ABS content of the blend. At around 10 wt % ABS content the dispersed phase domains are small, which are less deformable (and of lower elastic recoverability); hence they produce greater resistance to flow or higher melt viscosity. On the other hand, at around 20 wt % ABS content, the dispersed phase domains are larger and thus more easily deformable (and greater elastic recoverability); hence they

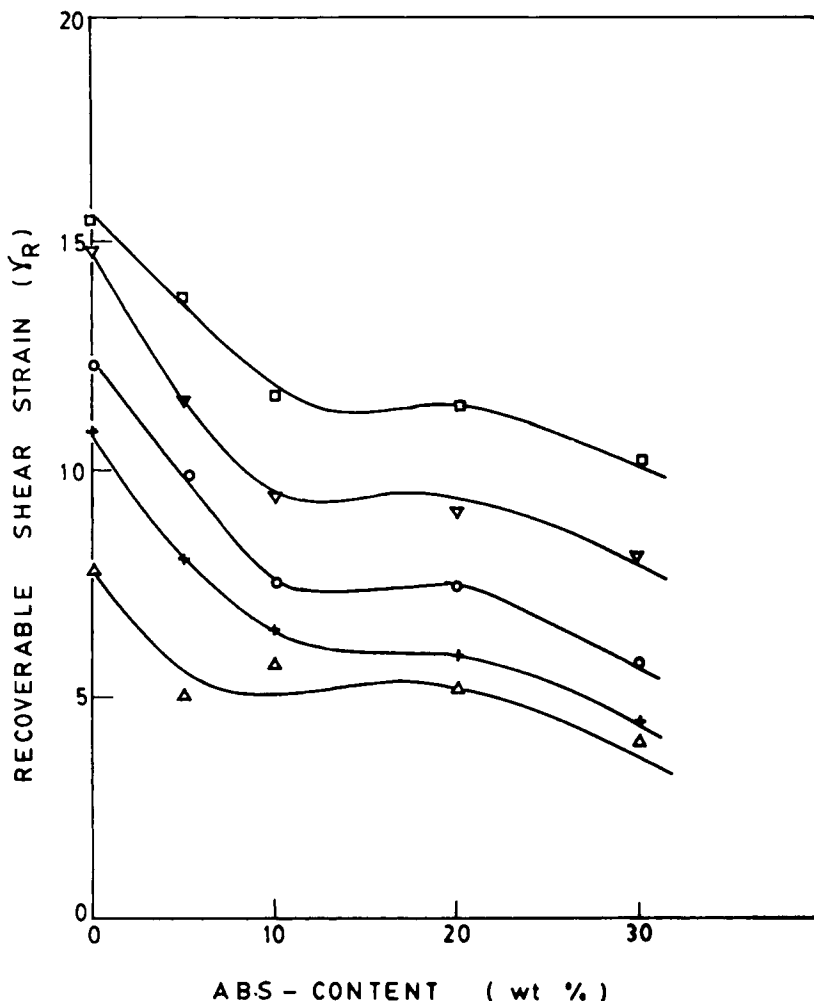


Fig. 11. Variation of recoverable shear strain γ_R with blend composition for PP/ABS binary blend at 200°C at various shear stresses (N/m^2): (Δ) 5.77×10^4 ; (+) 7.21×10^4 ; (O) 8.65×10^4 ; (∇) 1.01×10^5 ; (\square) 1.15×10^5 .

produce lesser resistance to flow, accounting thereby for the observed minima in melt viscosity and maxima in melt elasticity.

Melt Rheology of Ternary Blend PP/(ABS/LDPE)

Rheometric measurements for the ternary blend PP/(ABS/LDPE) were made using only one capillary die of $L/R = 60$. The Bagley correction was negligible at this high value of L/R , whereas the shear rates were corrected for the Rabinowitsch correction as per the procedure used above. Plots of τ_w as a function of $\dot{\gamma}$ thus obtained for the ternary blend are shown in Figure 12. Variation of τ_w with $\dot{\gamma}$ is quite linear on log-log scale and is consistent with the power law [eq. (6)] with value of $n' = 0.50 \pm 0.02$ varying very slightly with composition of the blend. This smaller variation in the value of n'

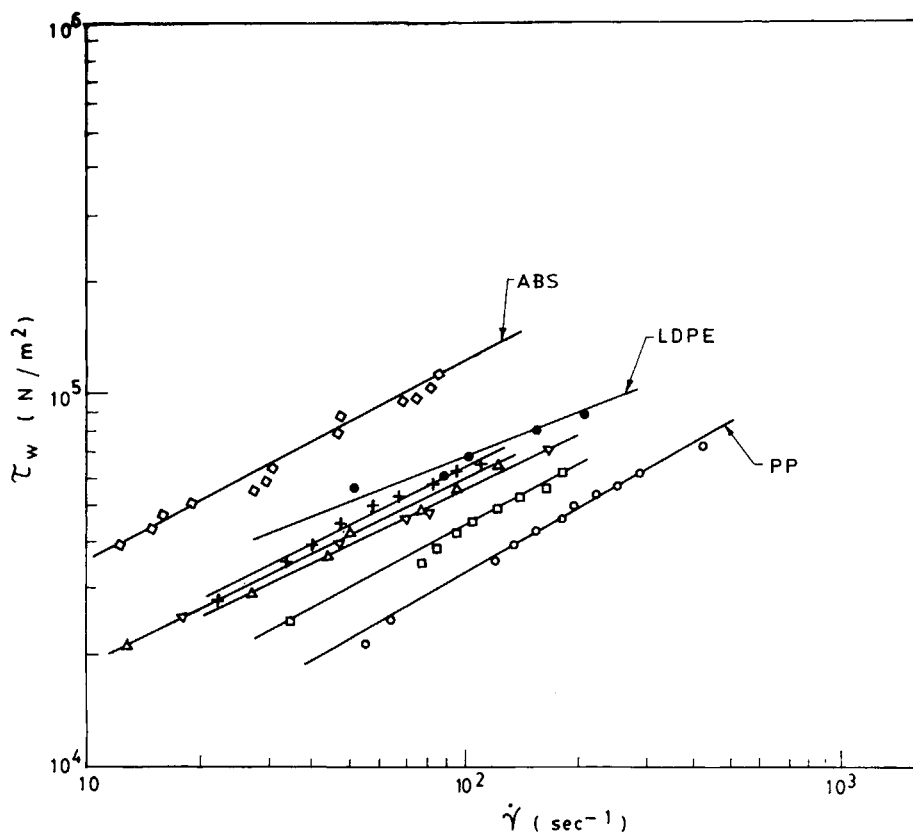


Fig. 12. Flow curves, in terms of shear stress τ_w as a function of shear rate $\dot{\gamma}$ at 200°C and $L/R = 60$ for PP/(ABS/LDPE) ternary blend at various ABS contents (wt %): (\square) 5; (∇) 10; (Δ) 15; (+) 20 and neat resins: (\circ) PP; (\diamond) ABS; (\bullet) LDPE.

implies a smaller effect of shear stress (or shear rate) on the role of ABS domains in melt flow properties [refer to relations (7) and (8)] of the ternary blend than the binary blend. This difference between the role of ABS domains in these binary and ternary blends might be due to the interfacial modification by the LDPE component in these ternary blends.

Data on the three neat resins PP, ABS and LDPE are also shown in Figure 12. The flow curves of the ternary blend are above that of PP and below those of ABS and LDPE. Though the data on PP and ABS are already compared in a previous section on binary blend, the values for LDPE may be added: melt viscosity $\eta = 700 \text{ N s/m}^2$ at shear rate 10^2 s^{-1} and power law exponent $n = 0.40$ for LDPE.

Variations of melt viscosity with blend composition for binary and ternary blends have some similarities in trends and differences in magnitudes, as illustrated in Figure 13. Melt viscosity at identical blending ratio and identical shear stress is lower for the ternary blend than the binary blend at low blending ratio, i.e., 10 wt % inclusion [inclusion being ABS in binary blend and (ABS + LDPE) in ternary blend]. At blending ratios higher than 10 wt % inclusion, melt viscosity of the ternary blend is higher than that of the binary

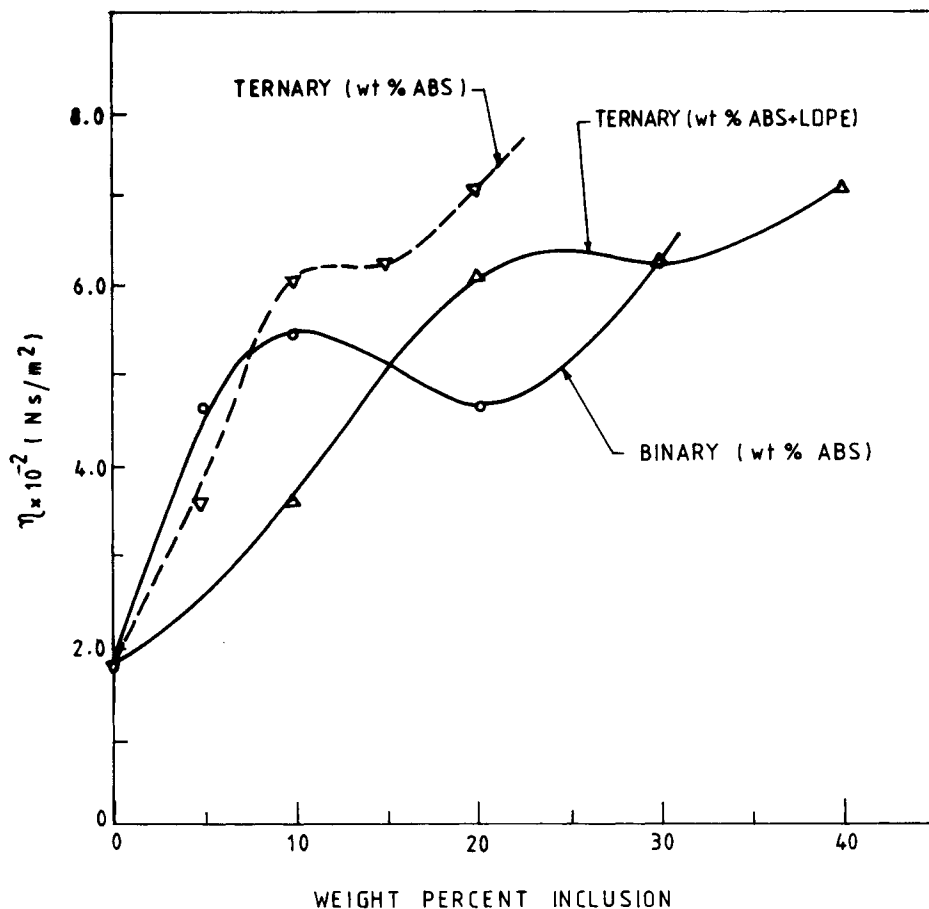


Fig. 13. Variation of melt viscosity η with wt % inclusion (inclusion being ABS or ABS + LDPE as indicated) for PP/ABS binary and PP/(ABS/LDPE) ternary blends at 200°C and comparable shear stress (5.77×10^4 N/m² for binary and 5.85×10^4 N/m² for ternary blend).

blend. These differences in the behaviors of the binary and ternary blend manifest the effect of the third component LDPE in the ternary blend, which produces a plasticizing effect when present in small quantities and obstruction to flow at higher proportions. Obstruction to flow of polypropylene by polyethylene is already recognized,⁴⁴ owing to the formation of network or interlocked morphology.

Furthermore, the melt viscosity of both binary and ternary blends show a maximum situated around 10 wt % ABS content for binary blend and around 20 wt % inclusion (ABS + LDPE) content in ternary blend. If the data for ternary blend are replotted as a function of ABS content, instead of total inclusion content (as done by the broken-line curve in Fig. 13), the positions of maxima in both the cases coincide with 10 wt % ABS. This indicates that 10 wt % ABS content is a critical value in both these binary and ternary blends, where melt viscosity shows a maximum. The melt viscosity then decreases and again starts rising with increasing ABS content. The ternary blend has higher melt viscosity than the binary blend beyond the 10 wt %

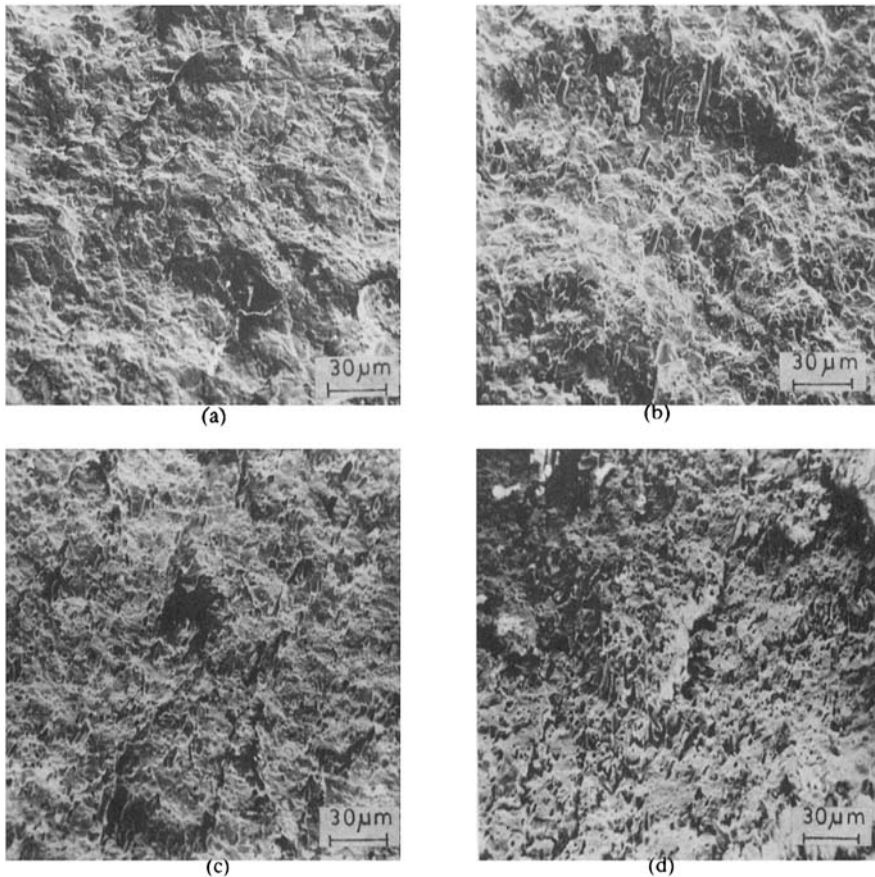


Fig. 14. Scanning electron micrographs of fracture surfaces of the PP/ABS binary blend at various blend compositions (wt % ABS content): (a) 5; (b) 10; (c) 20; (d) 30.

ABS content, which is attributed to the role of LDPE component in the ternary blend. Some criticality of 10% ABS content is observable also in Markin and Williams' results³² on PP/ABS blend with respect to tensile modulus and impact strength, which show maxima at 10% ABS content.

Melt elasticity of the ternary blend could not be investigated from these data. Owing to the high L/R ratio of the capillary used, the extrudate-swell ratio was too small to give any significant variation with blend composition.

State of Dispersion

Scanning electron micrographs of impact fractured surfaces of PP/ABS binary and the PP/(ABS/LDPE) ternary blend are shown in Figures 14 and 15, respectively. The samples were etched with toluene to dissolve out the ABS component from the fracture surface. The empty spaces left behind by the ABS domains are apparent in both these binary and ternary blends. The dispersion of ABS droplets in PP matrix is sufficiently fine and uniform and their number, shape, size, and size distribution vary with varying ABS

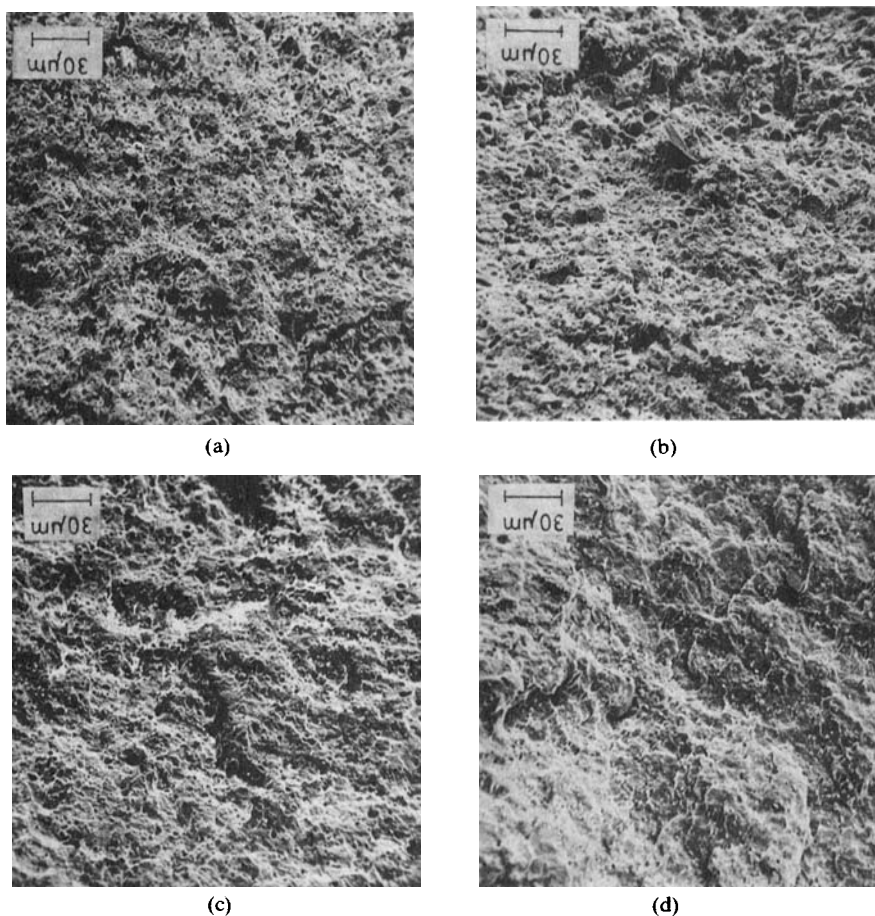


Fig. 15. Scanning electron micrographs of fracture surfaces of the PP/(ABS/LDPE) ternary blend at various blend compositions (wt % ABS content): (a) 5; (b) 10; (c) 15; (d) 20.

content of the blend in both these binary and ternary blends. The average size of the dispersed droplets varies from 2 to 5 μm , depending on the blend composition. In the binary blend at the lowest ABS content (5 wt %), the droplets are quite spherical with mean diameter about 2 μm [Fig. 14(a)]. At higher ABS content, (10–20 wt %) the droplets are quite large and deformed with mean width 4–5 μm of these elongated droplets [Figs. 14 (b), (c)]. At still higher ABS content (30 wt %), the droplets [Fig. 14(d)] are, though, large in number per unit area but less deformed and smaller in diameter than those observed for this binary blend in the medium ABS content range.

State of dispersion of the ternary blend differs from that of the binary blend. The dispersion is finer in the ternary blend than in the binary blend (Fig. 15). However, the size distribution of the dispersed droplets is broader in the ternary blend than the binary blend; the difference is distinct at the highest ABS content blends [compare Figs. 14(d) and 15(d)]. Mean diameter of the droplets is about 1 μm at the lowest ABS content (i.e., 5 wt %) and about 3 μm at the higher ABS contents. Unlike the binary blend, deformability of droplets is significant in the ternary blend, in spite of the great

abundance of large-size droplets in the medium-ABS-content range [i.e., 10–15 wt %; Figs. 15(b), (c)]. These large droplets are sometimes as big as 5 μm in diameter which compares well with the width of the elongated droplets observed in the binary blend. This illustrates the effect of LDPE component in modifying surface character of the dispersed droplets which in turn govern their deformability.

CONCLUSION

PP and ABS form a two-phase blend, and simple mixing in a single-screw extruder results in good dispersion of ABS in PP matrix. Mean size, size distribution, and deformability of the dispersed ABS droplets depend on blend composition. PP/(ABS + LDPE) ternary blend shows finer dispersion and less tendency of droplet deformation than PP/ABS binary blend. In the range of medium ABS content (10–20 wt %), the deformability of ABS droplets is significant in the binary blend which is accompanied by a maximum in melt viscosity, and minimum in melt elasticity variation. Variation of sharpness of these maximum and minimum with shear stress indicates the role of ABS droplets in their origin.

The pseudoplasticity increases (power law exponent decreases) with increasing ABS content for PP/ABS binary blend and shows insignificant variation in the PP/(ABS/LDPE) ternary blend. The ternary blend has a distinct advantage of lower melt viscosity than the binary blend at low blending ratios.

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