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Some Properties of Graft Copolymers

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ABSTRACT

Some properties of poly(vinyl chloride)-g-polyisobutylene graft copolymers are reviewed.

The heat stability of poly(vinyl chloride)-g-polyisobutylene (PVC-g-PIB) is shown in Fig. 1. There is improvement in heat stability after grafting. We think that the removal of the variety of defect sites reduces the thermal sensitivity of this material.

Figure 2 shows the apparent viscosity as a function of shear rate, using Geon. Two grafts are shown, containing 42 and 55% polyisobutylene. For comparison the viscosity of virgin poly(vinyl chloride) with 40 and 60% dioctyl phthalate (DOP) is shown. The results indicate that the grafts process more easily than the virgin poly(vinyl chloride). There is a considerable reduction of the apparent viscosity. The plasticizing action of the polyisobutylene chain is equivalent to about 40 to 60% of plasticizer in ordinary PVC.

Another interesting observation was one which is difficult to express quantitatively. This was that the equipment after the experiment was extremely clean, with little, if any, cleaning necessary after completion of the extrusion experiment.

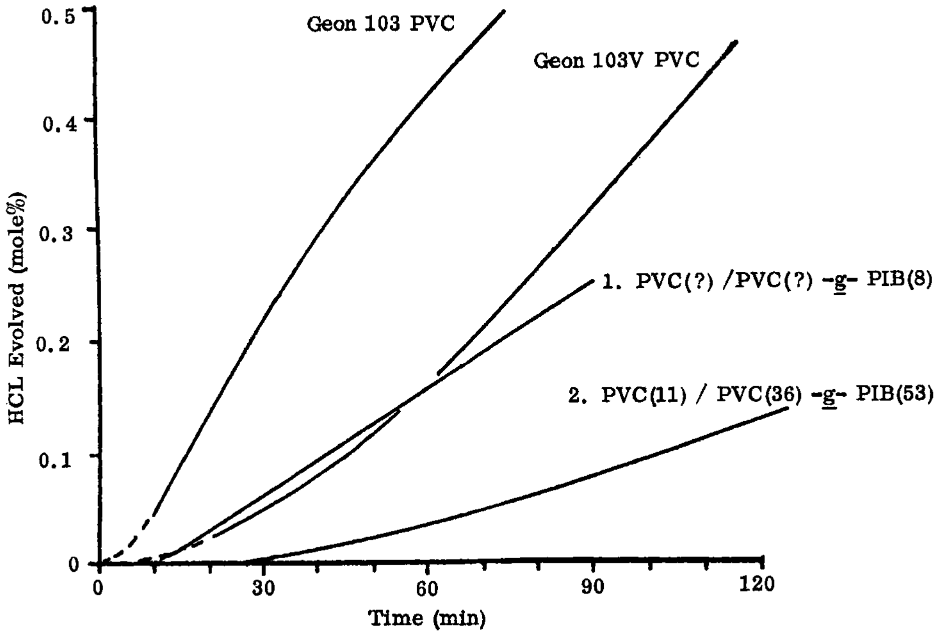

FIG. 1. Heat degradation behavior of PVC-g-PIB/PVC blends at 170°C in nitrogen: (1) [Me_3Al] = 3.68×10^{-2} mole/liter, -30°C, in CH_2Cl_2; (2) [Et_2AlC] = 2.12×10^{-2} mole/liter, -30°C, in 1,2-DCE. Numbers in parentheses indicate composition in weight percent.

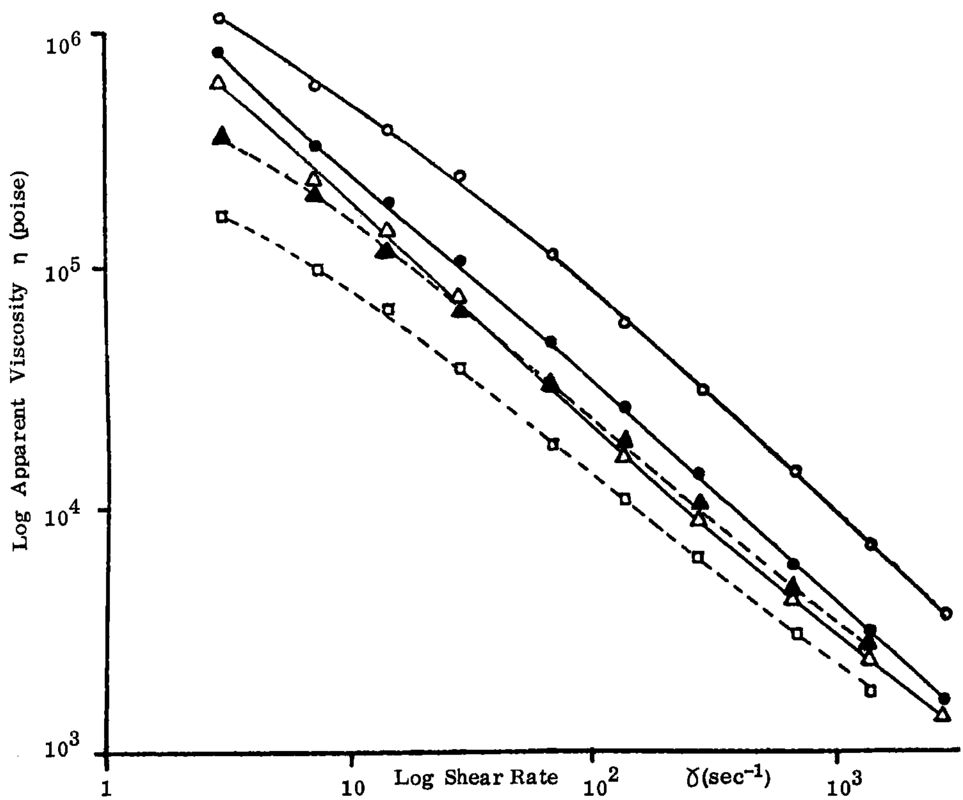

FIG. 2. Melt viscosity of PVC-g-PIB/PVC blends (Instron capillary rheometer at 190°C): (○) Geon 103 PVC; (●) PVC(?)/PVC(?)-g-PIB(42); (△) PVC (35)/PVC(10)-g-PIB(55); (▲) Geon 103 +40 phr DOP; (□) Geon 103 + 60 phr DOP.

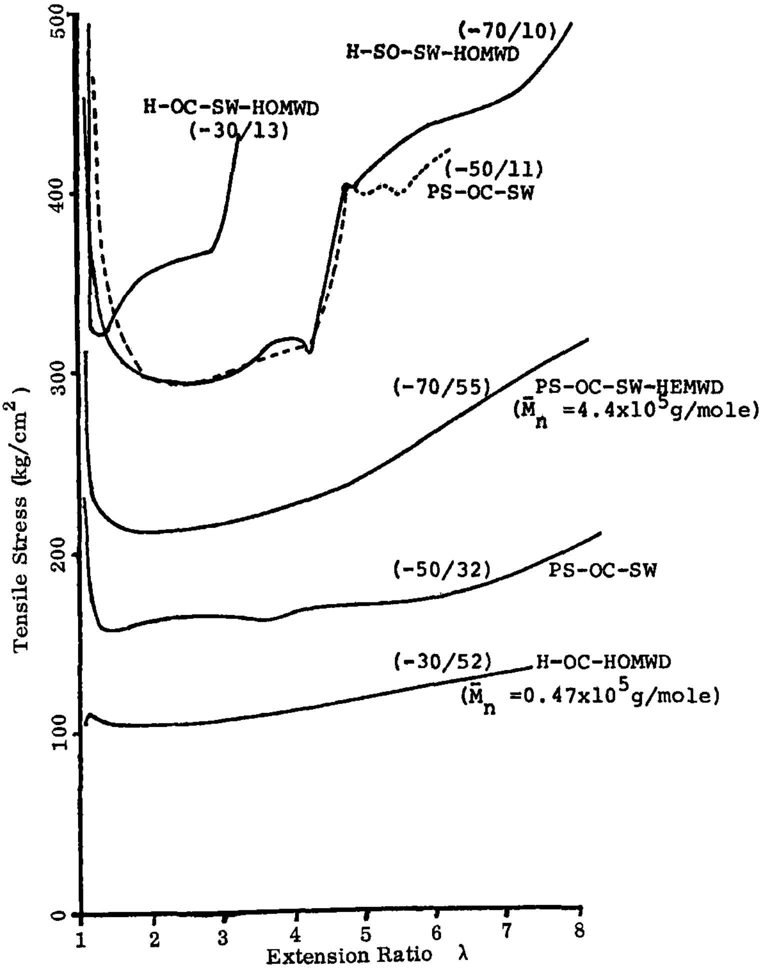

FIG. 3. Effect of composition and synthesis temperature on stress-strain behavior of PVC-g-PIB/PVC blends. Code: H = homogeneous film; OC = optically clear film; SO = slightly transluscent film; PS = phase-separated film; SW = stress-whitened on extension; HOMWD = Gaussian MWD; HEMWD = heterogeneous (bimodal) MWD. ($\overline{M}_n$ values for homoPIB = $\overline{M}_n$ PIB branches). Numbers in parentheses indicate synthesis temperature (°C)/polyisobutylene content (%).

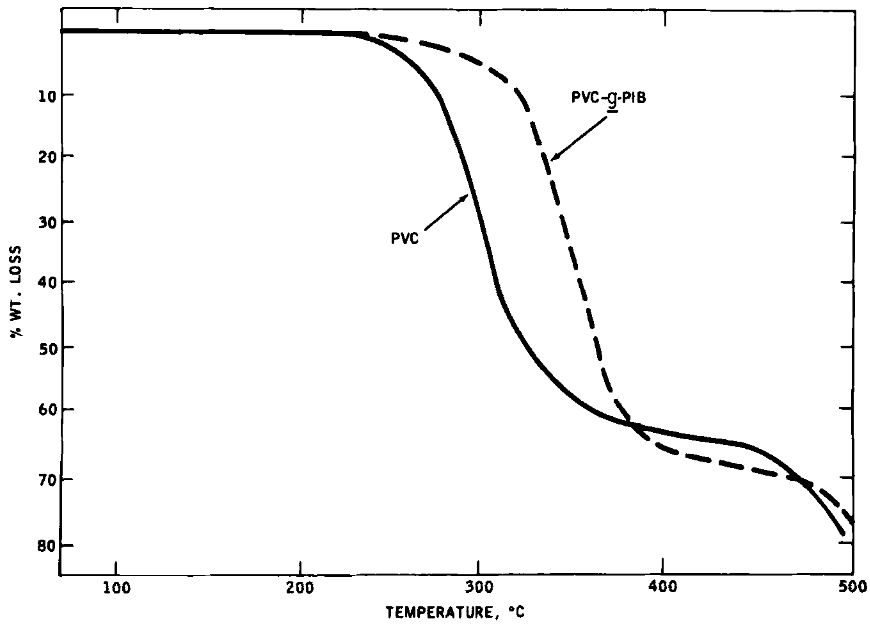

FIG. 4. Thermal gravimetric analysis (6°C/min in nitrogen) of poly(vinyl chloride) and poly(vinyl chloride)-g-polyisobutylene (suspension grafting in n-pentane).

Figure 3 shows the stress-strain curve of poly(vinyl chloride)-g-polyisobutylene. The numbers in parenthesis indicate the synthesis temperature and polyisobutylene contents.

This material behaves in a peculiar way. We do not understand the course of this stress-strain curve. There is both stress softening and a stress hardening. The elongation is extremely high, also the strength.

Figure 4 shows a suspension-grafted polyisobutylene and its heat behavior. The suspension medium was pentane. In the TG analysis the poly(vinyl chloride)-g-polyisobutylene has much higher heat stability than that of the virgin material, even though the grafting was a heterogeneous process.

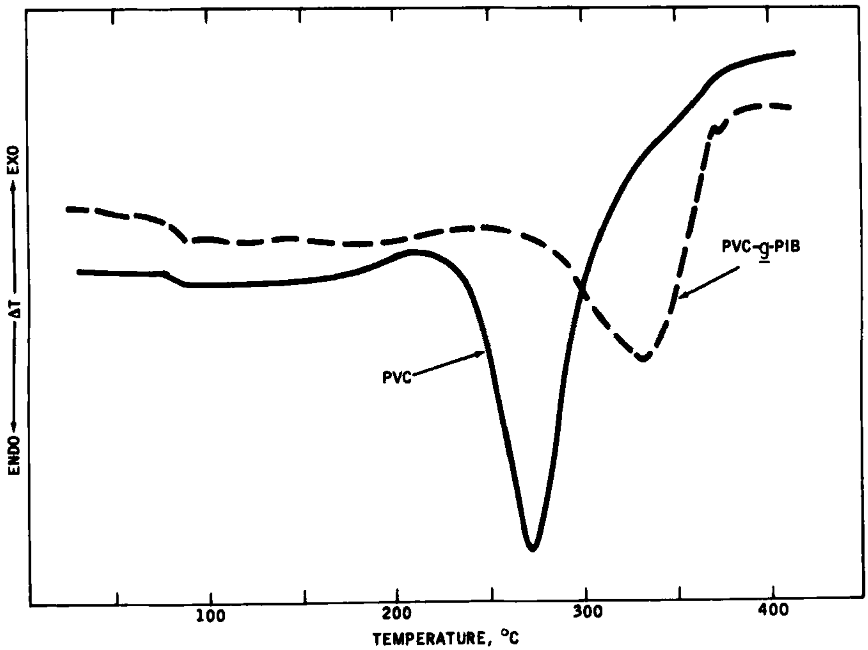

FIG. 5. Differential thermal analysis (10°C/min in air) of poly(vinyl chloride) and poly(vinyl chloride)-g-polyisobutylene (suspension grafting in n-pentane).

Figure 5 shows the differential thermal analysis (DTA) of a suspension-grafted material. The glass temperature at about 83°C is clearly visible for the grafted and nongrafted material. While there is a massive early degradation of poly(vinyl chloride), degradation is much delayed for the graft, so that the mechanism of the degradation must be quite different. Grafts remain essentially colorless even after 30 min at 170°C.