The Surface Energy of Poly(ethylene Terephthalate) Film

The surface energies of several industrial poly(ethylene terephthalate) (PETP) films were determined by the method of Kaelble[1] from which the surface energy γ_s including polar γ_s^p and dispersion γ_s^d contributions was calculated from a least-squares computer program. The seven liquids used are listed in Table I.

A drop of liquid was placed with a syringe on the surface of the PETP film. A photograph of the drop was taken with a Leitz Weitzler camera. Photographs of two drops per liquid per sample were taken from which contact angles were measured. Film and source were as follows: Scotchpar G, T & K, 3M Co.; Mylar A and T, E. I. du Pont de Nemours & Co.; Celanar, Celanese Corp.; Melinex, Imperial Chemical Industries.

The densities of these films were determined pycometrically with water at 25.0 ± 0.2°C. The film per cent crystallinity was then calculated by the method of Johnson.[2]

A plot of the film surface energy versus per cent crystallinity is shown in Figure 1. Peel adhesion values (180 degree peel at a rate of 230 cm/min) for two acrylate-type pressure-sensitive ad-

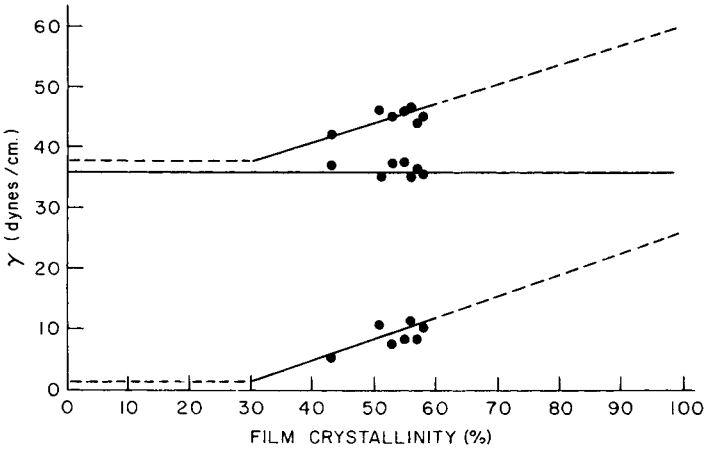

Fig. 1. The surface energy γ_s (top curve), including dispersion γ_s^d (middle curve) and polar γ_s^p (bottom curve) contributions vs. the per cent crystallinity of PETP film.

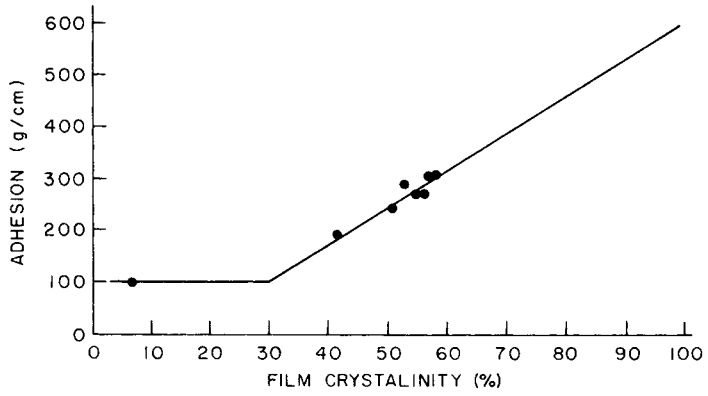

Fig. 2. Adhesion of 95.5/4.5 copolymer of isoocylacrylate and acrylic acid vs. per cent crystallinity of PETP film.

TABLE I
Dispersion and Polar Contributions to Liquid Surface Tension (dynes/cm) at $T = 20°C$

No.	Liquid	γ_L	γ_L^p	γ_L^d
1	water	72.8	21.8	51.0
2	glycerol	63.4	37.0	26.4
3	formamide	58.2	39.5	18.7
4	methylene iodide	50.8	48.5	2.3
5	α-bromonaphthalene	44.6	44.6	0
6	tricresyl phosphate	40.9	39.2	1.7
7	*n*-hexadecane	27.6	27.6	0

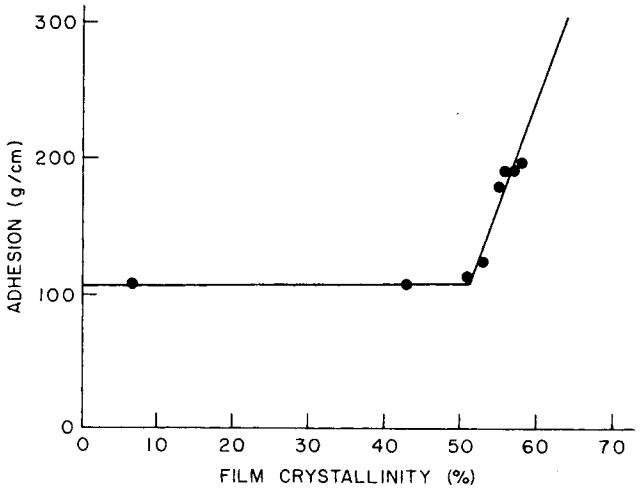

Fig. 3. Adhesion of 90/10 copolymer of isooctyl acrylate and acrylic acid vs. per cent crystallinity of PETP film.

hesives to the same film surfaces are shown in Figures 2 and 3. The adhesive represented by data in Figure 2 is a 95.5/4.5 copolymer of isooctylacrylate and acrylic acid; The second adhesive is a 90/10 copolymer of the same monomers.

The peel adhesion values show a definite linear increase with crystallinity. The film surface energy should also increase linearly since it has been indicated that adhesion to a surface is directly proportional to the surface energy.[3] Microphotographs of the film surfaces did not reveal any unusual differences in surface roughness. It is concluded that the degree of crystallinity of the surface is less than that of the bulk by virtue of the abrupt change in slope in each of the three plots.

References

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3. C. A. Dahlquist, *Aspects of Adhesion*, Vol. 5, D. J. Alner, Ed., Univ. of London Press, London, 1969, p. 183.

T. J. BURGER

3M Company—3M Center
St. Paul, Minn. 55101

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