PHYSICAL–THERMAL PROPERTIES

"Mylar"* polyester film retains good physical properties over a wide temperature range (—70°C to +150°C); and it is also used at temperatures from —250°C to +200°C when the physical requirements are not as demanding. Some physical and thermal properties of "Mylar" are summarized in Table I. Detailed information and other physical and thermal properties are described in the remaining pages of this bulletin.

TABLE I

TYPICAL PHYSICAL AND THERMAL PROPERTIES OF "MYLAR"* POLYESTER FILM

	Property	Typical Value 1 mil film		Unit of Measure	Test Method
		TYPE A	TYPE T		
PHYSICAL PROPERTIES AT 23°C AND 50% RH	Ultimate Tensile Strength (MD)	25,000	45,000	psi.	ASTM D 882-64T Method A (100% elongation per minute)
	Stress to produce 5% Elongation	15,000	23,000	psi.	
	Ultimate Elongation (MD)	120	40	%	
	Tensile Modulus (MD)	550,000	800,000	psi.	
	Impact Strength	6.0	6.0	kg-cm/mil	Du Pont Pneumatic Impact Tester
	Folding Endurance	14,000		cycles	ASTM D 2176-63T (1 kg loading)
	Tear Strength—propagating (Elmendorf)	20	20	grams/mil	ASTM D 1922-61T
	Tear Strength—initial (Graves)	800	450	grams/mil	ASTM D 1004-66
	Tear Strength—initial (Graves)	1,800	1,000	lbs./inch	ASTM D 1004-66
	Bursting Strength	66	55	psi.	ASTM D 774-63T
	Density	1.395	1.377	grams/cc	ASTM D 1505-63T
	Coefficient of Friction—Kinetic (film-to-film)	.45	.38	—	ASTM D 1894-63
	Deformation Under Load	0.11	—	%	ASTM D 621-64 Method A, 500 lb. load
THERMAL	Melting Point	250°C	250°C		Fisher-Johns
	Zero Strength Temp.	248°C	248°C		Du Pont Test**
	***Penetration Temp.	230°C; 270°C	230°C; 270°C		ASTM D 876-65
	Coefficient of Thermal Expansion (30°C-50°C)	1.7×10^{-5}	—	inch/inch/°C	Modified ASTM D 696-44
	Coefficient of Thermal Conductivity (1000 "Mylar" A at 25 to 75°C)	1.05	—	(BTU) (inch) / (ft.²) (hr) (°F)	
		3.7×10^{-4}	—	(cal) (cm) / (cm²) (sec) (°C)	
	Specific Heat (25°C)	.28	—	cals/gm/°C	
	Heat Sealability	No	No		
	Flammability	Slow to self extinguishing	Slow to self extinguishing		

*Reg. U.S. Pat. Off.

**The temperature at which a single sheet of film over a ½" diameter heated rod supports a tensile load of 20 psi. for 5 seconds.

***1000 gm. weight on [illegible] dia. ball, 0.5°C/min. rise rate [illegible]

TENSILE PROPERTIES

Figure 1

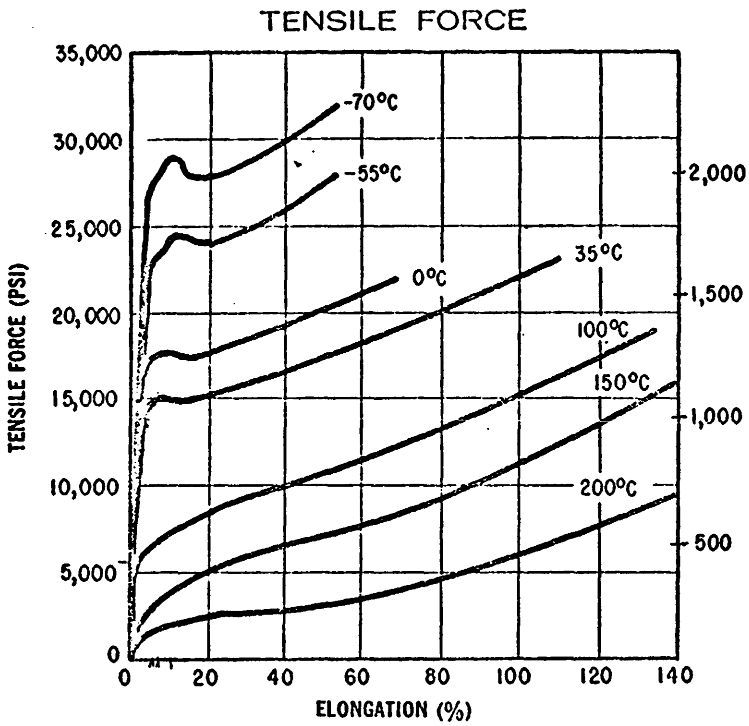


Figure 2

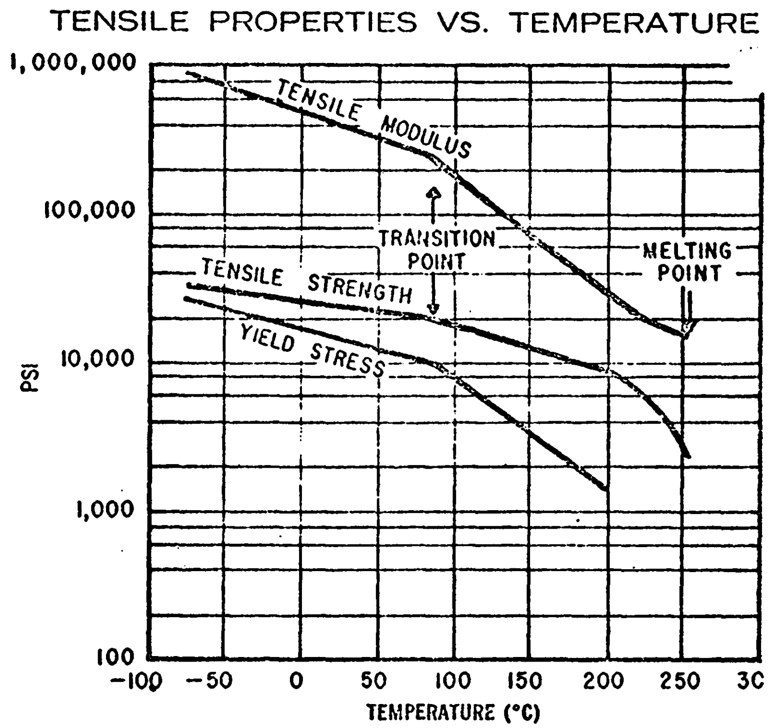


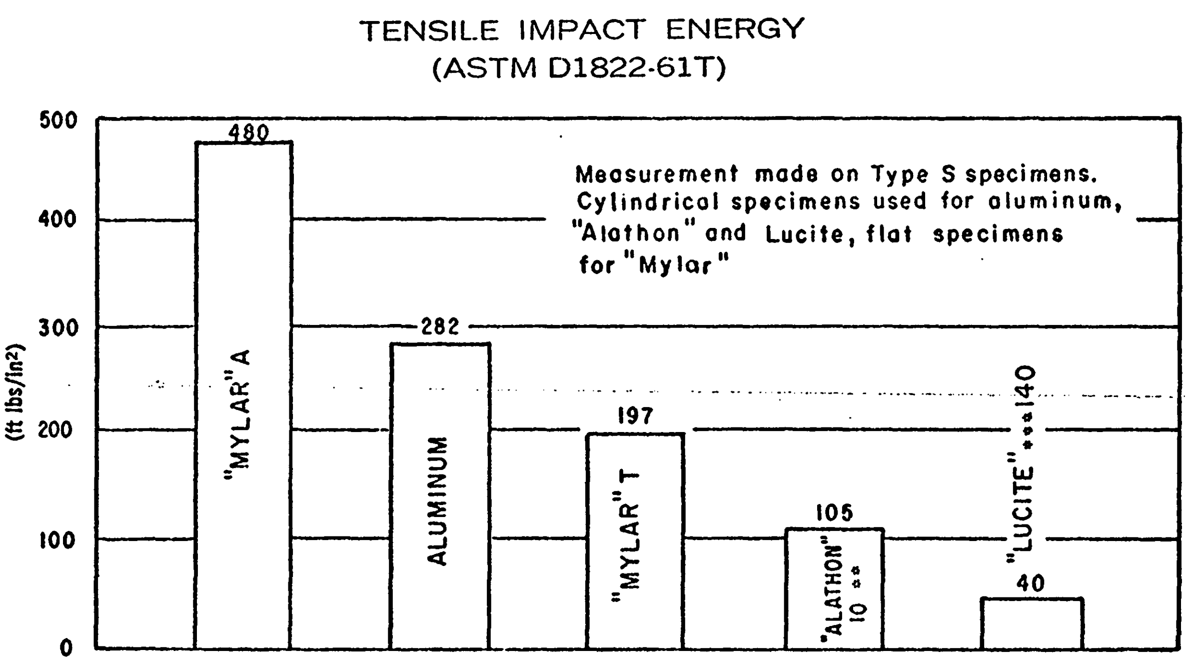
Figure 1 shows typical stress-strain curves for "Mylar" polyester film at various temperatures.

Temperature affects the tensile properties of "Mylar"; data on a typical sample are shown in Figure 2. When considering the use of "Mylar" at high temperatures, reference should be made to the last five pages of this bulletin.

TENSILE IMPACT ENERGY

The tensile impact energy test* is a modification of the notched Izod impact test, which compensates for the errors induced by the flexibility and notch sensitivity of many plastic materials. The tensile impact energy test has been found to correlate well with actual drop tests.

Figure 3



*See "Modern Plastics", June 1956, P. 199-206 for a description of the procedure for the tensile impact energy test.
**Reg. U.S. Pat. Off. for Du Pont's Polyethylene Resins.
***Reg. U.S. Pat. Off. for Du Pont's Acrylic Resins.

COMPRESSIVE PROPERTIES

Compression tests provide information about the compressive properties of plastics when employed under relatively low uniform rates of uniaxially applied loading. Data on the compressive properties of "Mylar" were obtained in accordance with ASTM D 695-63T except that a cylindrical pile of pieces one inch high, one inch in diameter, was used. The data are summarized in Table 2.

When loaded in compression, "Mylar" did not exhibit a yield point nor did it fail in compression by a shattering fracture. Therefore, it would be inappropriate to report any value as a compressive strength. However, the stress at 2% deformation and the stress at 1% offset have been calculated. Since the latter stress occurs at very nearly the point where the stress-strain curve begins to deviate markedly from the initial relatively linear portion, it is probably a meaningful upper limit for any application where "Mylar" is loaded in compression.

TABLE 2

COMPRESSIVE PROPERTIES
OF "MYLAR" POLYESTER FILM

Film Type	Compressive Modulus, psi.	Stress (psi.) at 2% Deformation	1% Offset Stress (psi.)	Maximum Stress During Test (psi.)	Maximum Strain During Test (%)
1000 "Mylar" A	413,000	8,450	16,800	30,000	23
1400 "Mylar" A	397,000	8,230	16,600	30,000	27

SHEAR STRENGTH

"Mylar" has a shear strength which is significantly higher than published data for other polymeric materials such as acetals, nylons, and polyolefins. Shear strength was measured by a punch-type of test according to ASTM D 732-46 and is reported in the pounds of force to shear divided by the product of the circumference and the thickness. These tests showed that 5 and 10 mil "Mylar" films have shear strengths of 21,500 and 19,500 psi, respectively.

DIMENSIONAL STABILITY

The main factors affecting dimensional stability of a film are creep, strain relief, thermal expansion, and hygroscopic expansion. Typical values for these factors are described below for "Mylar".

CREEP

"Mylar" is unusually resistant to creep. Two values measured at room temperature are 0.1% after 260 hours at 2980 psi and 0.2% after 1000 hours at 3000 psi. After 4000 hours at 500 psi in 100°C oven a creep of 0.9% was measured.

STRAIN RELIEF

Strain relief (also called residual shrinkage) occurs when a film is heated to an elevated temperature. The resulting shrinkage of the film is merely a relaxation of strains induced during the manufacture of the film or during processing of the film. Once these strains are relieved at a specific temperature, there should be no further shrinkage due to strain relief as long as that temperature is not reached.

Some typical curves of shrinkage due to strain relief are shown in Figures 4 and 5 for two types of "Mylar" polyester film. Controlled shrinkage levels are provided for those industries where they are required in the manufacture or use of the product. For example, the 50% shrinkage at 100°C of "Mylar" Type HS is used as an aid in manufacturing some products.

Figure 4

SHRINKAGE vs. TEMPERATURE

100 "MYLAR" S

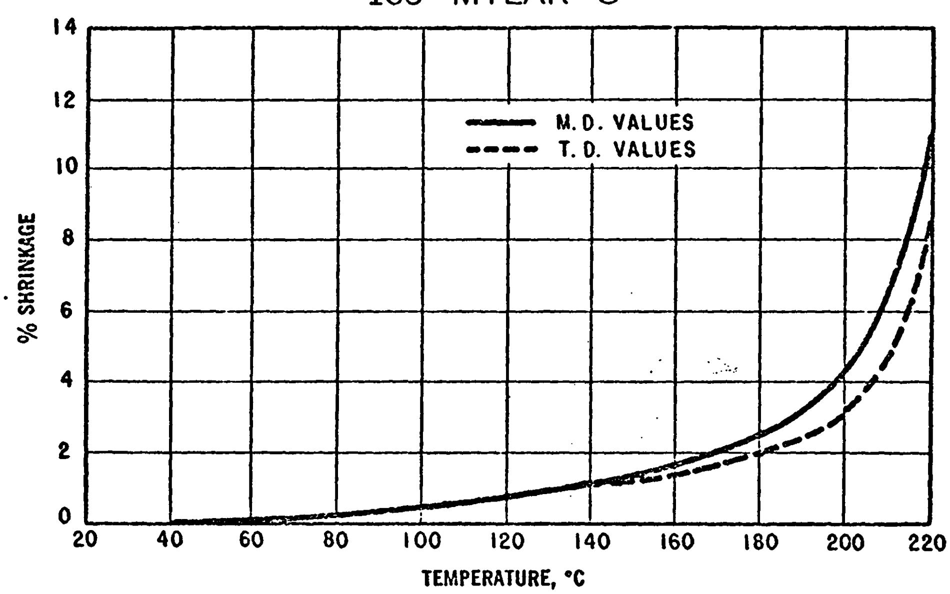


Figure 5

SHRINKAGE vs. TEMPERATURE

750 "MYLAR" D