MATERIAL STRENGTH PROPERTIES OF STARTEX SL 1883 FILM

A test program conducted for the
National Center for Atmospheric Research
by the Hauser Research and Engineering Company
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National Center for Atmospheric Research
Boulder, Colorado

NCAR Technical Note TN-9

1965

PREFACE

This report is one of a series prepared for the Materials Research Project of the NCAR Scientific Balloon Facility. The Materials Research Project is one of several related efforts undertaken by the National Center for Atmospheric Research (NCAR) to increase the reliability, and to extend the capabilities, of scientific ballooning.

The present report covers certain investigations performed by Hauser Research and Engineering Company, Boulder, Colorado, under subcontract with UCAR. Other reports published in this balloon materials research series include: FRB-1-64, Tests of Balloon Materials; FRB-2-64, Standard Test Methods for Balloon Materials; FRB-3-64, Non-Standard Tests for Balloon Materials; FRB-4, Strength Characteristics of DuPont "Surlyn A" Film; and NCAR Technical Note TN-5, Material Strength Properties of Visqueen X-124 Film.

SUMMARY AND CONCLUSION

A sample of 0.75-mil Startex SL 1883, a new film submitted by the Applied Science Division of Litton Industries, was tested to evaluate its mechanical properties. Its properties compare favorably with those of the new high-quality balloon films.

I. INTRODUCTION

The National Center for Atmospheric Research requested a series of tests to determine the mechanical properties of a new 0.75-mil film, "Startex SL 1883," submitted by the Applied Science Division of Litton Industries. Standard test procedures of earlier test programs were used, and the resulting data for the SL 1883 film are presented in this report. Test results are given for the properties of: ultimate tensile strength, tensile yield strength, ultimate elongation, tensile modulus of elasticity, tear initiation, and tear propagation; all at temperatures of both 25°C and -80°C.

II. DESCRIPTION OF FILM SAMPLE

A sample roll of Startex SL 1883 film was forwarded to the National Center for Atmospheric Research by the Applied Science Division of Litton Industries. The sample was a piece of lay-flat polyethylene tubing, nominally 0.75 mil thick, 54 in. wide and about 15 ft long, wrapped on a core bearing the marking "S4T". The film surface was wrinkled slightly and visual inspection of the film showed the appearance of occasional gel particles.

The following properties were found for the film:

Specific Gravity	0.972 (by weight and thickness)
Weight/Area	4.0 lb/1000 sq ft
Thickness, average	0.806 mil

III. TESTS AND RESULTS

Tests procedures, temperature environments (25°C and -80°C), laboratory conditions and data reduction methods described in Refs. 1-4, applied to the present tests. Data from this series of tests are shown in Table 1. Tables 2 and 3 compare these data with results obtained from previous test programs mentioned in Refs. 2-4. Figure 1 shows typical tensile modulus curves for the Startex material, compared with those for other commercial films.

Stress patterns were observed using polaroid sheets during some of the tensile tests at 25°C. Stress concentrations appeared around flaw areas (gel particles) and the film yielded first at these points.

A spectral analysis of the SL 1883 film displayed absorption bands very similar to those of Visqueen A (Ref. 1, p 45) and Visqueen X-124 (Ref. 4).

At 25°C the Startex film had slightly lower values than Visqueen X-124 for ultimate tensile strength and ultimate elongation. Higher values were found for the tensile yield strength, tensile modulus, and tear initiation. Tear propagation was higher in the machine direction but slightly lower in the transverse direction than the X-124 values.

At -80°C the SL 1883 values were generally comparable to those of Visqueen X-124, except for tear initiation and tear propagation values which were slightly lower.

REFERENCES

1. Tests of Balloon Materials, NCAR Facilities Report FRB-1-64, National Center for Atmospheric Research, Boulder, Colo., November 1964.

2. Standard Test Methods for Balloon Materials, NCAR Facilities Report FRB-2-64, National Center for Atmospheric Research, Boulder, Colo., November 1964.

3. Strength Characteristics of DuPont "Surlyn A" Film, NCAR Facilities Report FRB-4, National Center for Atmospheric Research, Boulder, Colo., April 1965.

4. Material Strength Properties of Visqueen X-124 Film, NCAR Technical Note TN-5, National Center for Atmospheric Research, Boulder, Colo., June 1965.

Table 1

SUMMARY OF TEST DATA ON STARTEX SL 1883 FILM (0.75 mil nominal)

(M = Machine, T = Transverse, C = Across Crease)

Property tested	25°C			-80°C		
	Direction			Direction		
	M	T	C	M	T	C
Ultimate Tensile Strength						
Average, psi	2920	2110	2280	8990	8530	8350
Average, lb/in. width	2.35	1.70	1.84	7.25	6.91	6.74
No. of Samples Tested	5	5	5	5	5	5
Standard Deviation	578	390	262	1340	910	234
Deviation Coefficient	.198	.185	.115	.149	.107	.028
Tensile Yield Strength						
Average, psi	1070	1110	---	6450	6660	---
Average, lb/in. width	.86	.89		5.2	5.4	
No. of Samples Tested	5	5	0	5	5	0
Standard Deviation	93	49	---	548	800	---
Deviation Coefficient	.087	.044	---	.085	.120	---
Elongation at Yield (no deviation)	8	8		3	3	
Ultimate Elongation						
Average, %	192	373	394	69	23	21
No. of Samples Tested	5	5	5	5	5	5
Standard Deviation	32	84	31	25	3.4	1.6
Deviation Coefficient	.168	.226	.078	.358	.149	.076

Table 1 (cont'd)

Property tested	25°C			-80°C		
	Direction			Direction		
	M	T	C	M	T	C
Tensile Modulus (Initial Tangent)						
Average, psi	23,600	25,400	---	315,000	325,000	---
No. of Samples Tested	5	5	0	5	5	0
Standard Deviation	3,300	4,200	---	14,800	34,400	---
Deviation Coefficient	.140	.165	---	.047	.106	---
Tear Initiation						
Average, lb/in.	541	511	---	1250	1080	---
No. of Samples Tested	5	5	0	5	5	0
Standard Deviation	54	42	---	147	181	---
Deviation Coefficient	.100	.082	---	.118	.168	---
Tear Propagation						
Average, lb/in.	474	309	---	1090	782	---
No. of Samples Tested	5	5	0	5	5	0
Standard Deviation	61	33	---	162	46	---
Deviation Coefficient	.130	.107	---	.149	.059	---

Table 2

COMPARISONS OF FILMS TESTED AT 25°C

(elongation at yield, 8% for all samples; no deviation)

Film	Weight (lb/1000 sq ft)	Direction*	Ultimate Tensile Strength		Tensile Yield Strength		Ultimate Elongation		Tensile Modulus (Initial Tangent)		Tear Initiation		Tear Propagation	
			average (psi)	d.c.**	average (psi)	d.c.	average (%)	d.c.	average (psi)	d.c.	average (lb/in.)	d.c.	average (lb/in.)	d.c.
Startex		M	2920	.198	1070	.087	192	.168	23,600	.140	541	.100	474	.130
SL 1883	4.0	T	2110	.185	1110	.044	373	.226	25,400	.165	511	.082	309	.107
0.75-mil		C	2280	.115	--	--	394	.078	--	--	--	--	--	--
Visqueen		M	3190	.158	890	.082	308	.124	13,300	.103	400	.125	330	.129
X-124	4.1	T	4010	.155	920	.148	420	.115	11,700	.149	460	.072	330	.072
0.75-mil		C	3690	.098	--	--	436	.094	--	--	--	--	--	--
Visqueen		M	3970	.170	850	.040	456	.170	14,400	.035	581	.036	416	.018
A	7.4													
1.5-mil		T	3510	.180	800	.027	442	.110	13,500	.130	440	.037	388	.036
Consolidated		M	2140	.016	1020	.094	200	.300	15,200	.040	590	.048	510	.049
GF19X	4.8													
1-mil		T	1330	.100	1000	.059	236	.320	17,200	.070	510	.087	360	.110
Winzen Strato-		M	2054	.087	720	.078	193	.249	13,200	.166	374	.056	245	.114
film 320	3.3													
0.75-mil		T	1734	.109	848	.090	285	.233	16,300	.117	360	.086	240	.054
Surlyn		M	2936	.080	1580	.054	241	.149	38,800	.034	456	.063	354	.062
A	5.2													
1-mil		T	1900	.220	1500	.020	231	.302	32,300	.039	470	.074	214	.201

* M = Machine, T = Transverse, C = Across Crease
** deviation coefficient

Source: Data from Hauser Research & Engineering testing programs and Refs. 1, 3 and 4

Table 3

COMPARISONS OF FILMS TESTED AT -80°C

(elongation at yield, 3% for all samples; no deviation)

Film	Weight (lb/1000 sq ft)	Direction*	Ultimate Tensile Strength		Tensile Yield Strength		Ultimate Elongation		Tensile Modulus (Initial Tangent)		Tear Initiation		Tear Propagation	
			average (psi)	d.c.**	average (psi)	d.c.	average (%)	d.c.	average (psi)	d.c.	average (lb/in.)	d.c.	average (lb/in.)	d.c.
Startex SL 1883 0.75-mil	4.0	M	8990	.149	6450	.085	69	.358	315,000	.047	1250	.118	1090	.149
		T	8530	.107	6660	.120	23	.149	325,000	.106	1080	.168	782	.059
		C	8350	.028	--	--	21	.076	--	--	--	--	--	--
Visqueen X-124 0.75-mil	4.1	M	8870	.081	6230	.104	48	.300	317,000	.152	1580	.083	1210	.140
		T	9650	.093	5740	.094	43	.274	272,000	.124	1420	.040	1190	.089
		C	9290	.127	--	--	49	.420	--	--	--	--	--	--
Visqueen A 1.5-mil	7.4	M	8490	.026	5690	.125	45.5	.500	373,000	.110	1190	.140	740	.170
		T	7540	.084	6500	.081	7.3	.420	403,000	.076	1040	.091	710	.098
Consolidated GF19X 1-mil	4.8	M	10,300	.200	5420	.155	206	.120	339,000	.130	1400	.064	1080	.100
		T	7500	.024	5470	.127	22.2	.530	468,000	.095	970	.035	750	.130
Winzen Stratofilm 320 0.75-mil	3.3	M	6984	.041	4250	.041	78	.105	245,000	.115	1134	.016	962	.155
		T	7254	.033	4900	.028	22	.264	304,000	.049	1012	.131	676	.197
Surlyn A 1-mil	5.2	M	9040	.096	4790	.028	20	.308	334,000	.200	756	.102	448	.064
		T	8340	.092	4400	.013	19	.196	216,000	.094	736	.161	404	.165

* M = Machine, T = Transverse, C = Across Crease
** deviation coefficient

Source: Data from Hauser Research & Engineering testing programs and Refs. 1, 3 and 4

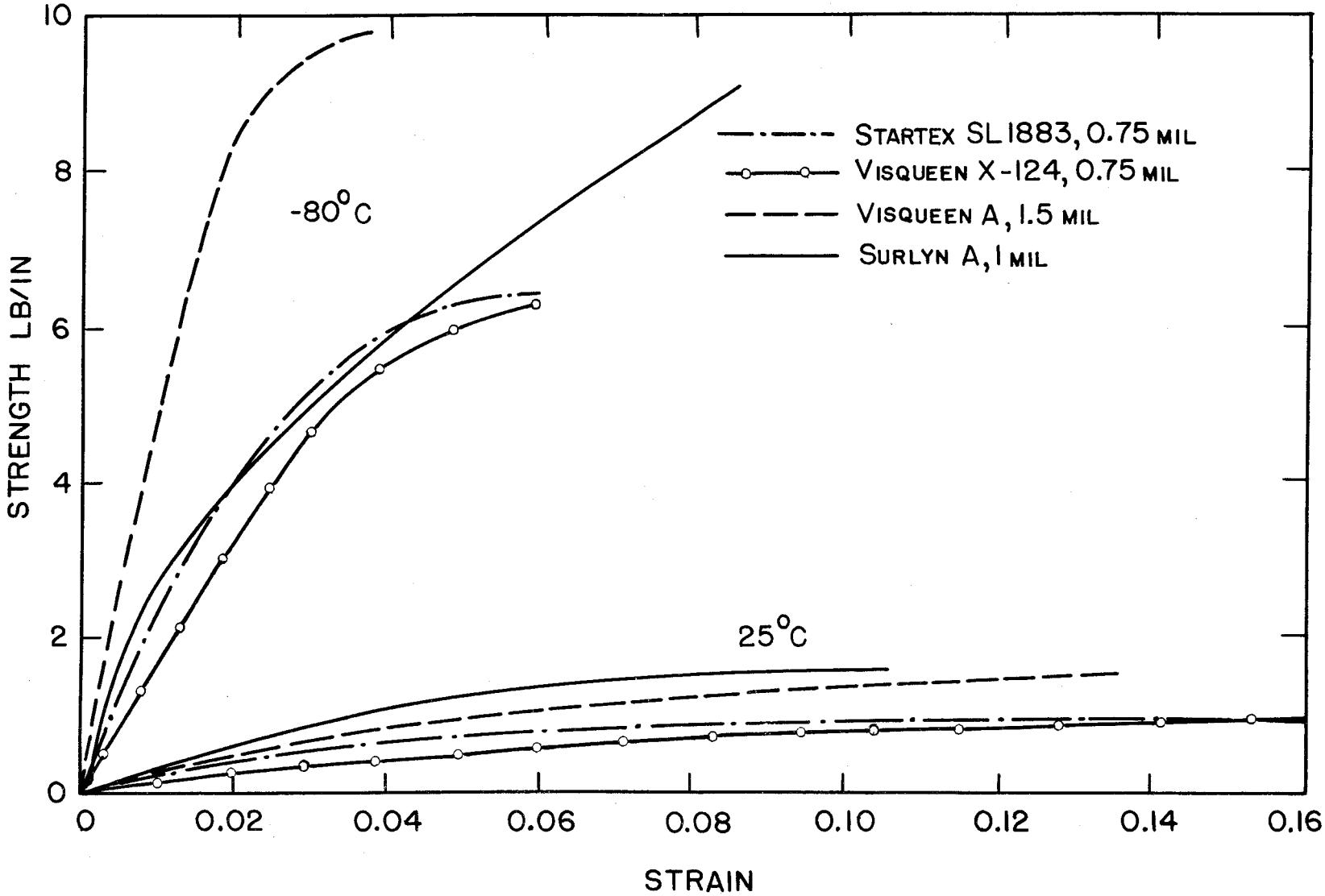

FIG. 1--TYPICAL MODULUS CURVES (MACHINE DIRECTION)