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LIQUID POLYMERS AS COATINGS FOR IMPROVED COATED FABRICS

(Supplement to RE-TR-71-51)

TECHNICAL REPORT

William F. Garland

September 1972

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RESEARCH DIRECTORATE
WEAPONS LABORATORY, WECOM
RESEARCH, DEVELOPMENT AND ENGINEERING DIRECTORATE
U. S. ARMY WEAPONS COMMAND

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Rock Island, Ill. 61201

ABSTRACT

Results are presented for the second years' effort of a two-year program initiated by personnel of the Research Directorate, Weapons Laboratory, WECOM concerning the use of liquid polymers as coatings for fibrous and nonfibrous substrates to provide improved weapon accessories such as gun covers and cleaning kit packets. Both pigmented and nonpigmented coatings were investigated.

Application of solvent-diluted polymer coatings to woven substrates caused a significant loss in cross-direction breaking strength.

Base or tie coats (consisting of liquid diamines applied to the substrate prior to application of liquid polymers) did not significantly improve the tear strength of the coated fabrics made from either woven or nonwoven substrates.

Except for the Estane solution coating, the polyurethane liquid polymers were generally resistant to a hydrocarbon fuel, lubricating oil, and insect repellent.

Six months' open sunlight aging in Panama was generally more severe than rain forest aging on both the pigmented and nonpigmented coated fabrics.

The best combination of breaking and tear strength and resistance to accelerated aging was obtained with either a pigmented or nonpigmented liquid polyurethane coated on a Betaglass/Dynel substrate. These experimental materials had abrasion resistance equal to or better than that of the vinyl control and two to three times better than that of the neoprene control. The black pigmented material suffered little or no loss in tear strength after accelerated aging while the control materials lost 10 to 20 per cent in tear strength.

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OBJECTIVE

The objective of the program was to investigate the use of liquid polymers as coatings for fabrics to meet specific Army weapon system needs, including flexibility at low temperatures, resistance to abrasion and, good environmental stability.

BACKGROUND

Coated fabrics are used in a wide variety of Army applications such as tarpaulins, gun covers, helicopter covers, pneumatic floating equipment, aircraft protectors, air supported shelters, gun shield mantle covers and fuel storage containers.

The bulk of these coated fabrics is prepared by application of solid rubber or rubberlike coatings to various substrate fabrics. The largest volume of commercial coated fabrics is in the area of coated polyvinyl chloride materials.[1,2] Industry primarily supplies neoprene and vinyl coated fabrics to the Army.

Although satisfactory for most civilian needs, current industrial coated fabrics do not meet these specialized requirements of the military for flexibility at low temperature, abrasion resistance, and fungus resistance.

Liquid polymers (polymeric materials fluid at room temperature or readily liquified by the process of heating without causing degradation) with many of these specialized properties are currently available. Liquid polymers are also reportedly superior to the solid materials (i.e., neoprene and vinyl) in several ways. They are normally ready to use as received and need no laborious production workup, little or no solvents are required and, as a result, these liquid polymers exhibit little shrinkage. Despite their many good features, very little effort has been expended by industry, in the use of liquid polymers as fabric coatings.

Previous work in this area[3] indicated that laboratory prepared coated fabrics made with liquid polyurethanes had good abrasion, ozone, and low-temperature resistance.

The work reported here was initiated by personnel of the Research Directorate, Weapons Laboratory, WECOM, and is a continuing investigation of the feasibility of the use of "liquid" polymers as coatings for fibrous substrates to obtain improved coated-fabrics.

APPROACH

As previously reported,[3] the liquid polyurethane materials were the best of the liquid polymers tested. For this reason, only polyurethanes were investigated during this second year's activity.

The liquid polymers and fibrous substrates obtained for laboratory fabrication of coated fabrics are shown in Table I. Two commercial coated-fabrics, i.e., Type II, Class 2 (vinyl) and Type III, Class B (neoprene), meeting the requirements of Specification MIL-C-20696[4] were used as controls.

A solid (resinous) polyurethane (Estane 5714 F-1) was included in the test program for comparison purposes. Two of the liquid polymers were semisolid at room temperature.

From 15 to 20 techniques are used to coat various textile materials, the two most often used are the knife and the roller coating techniques. The only laboratory bench coater (of the reverse roll type) available at this Directorate was not adaptable for use with the various viscosities of coating materials utilized, i.e., the very thin, watery Chemglaze material did not adhere to the rolls and the viscous Adiprene material was too tacky. In light of the above, dip coating was used since it was adaptable in all cases.

The following procedures were used to dip coat the polymers investigated:

Vibrathane B-602 and B-605. These polyether urethanes are solid in the as-received state. Used in the molten condition, they yielded extremely thick coatings. When diluted to 50 per cent solids with toluene, the polymer solution could be used at room temperature. Since most urethanes can be partially cured by reaction with moisture, pieces of the substrate materials (15 by 30 inches) were dip-coated in the polymer solution, by the method indicated in the figure, drained and hung in a controlled atmosphere (73°F, 50 per cent R.H.) for three days. The resultant coatings were tough, smooth, and relatively bubble-free.

TABLE I

IDENTIFICATION OF SUBSTRATES AND LIQUID POLYMER COATINGS

Substrate	Trade Name	Manufacturer
Nylon (open mesh)	A-2951/6	Stern and Stern Textiles, Inc.
Betaglass/Dynel	GV-4030-01	West Point Pepperell
Spunbonded Nylon	Cerex 5915	Monsanto Co.
Spunbonded Polyester	Reemay 2011	E.I. Dupont

Liquid Polymer Coating	Trade Name	Manufacturer
Polyurethane (polyether)	Adiprene L-100	E.I. Dupont
Polyurethane (polyester)	Chemglaze Z004	Hughson Chemical Co.
Polyurethane (polyether)	Vibrathane B-602	Uniroyal
Polyurethane (polyether)	Vibrathane B-605	Uniroyal
Polyurethane (polyether)	Estane 5714 F-1	B. F. Goodrich Chemical Co.

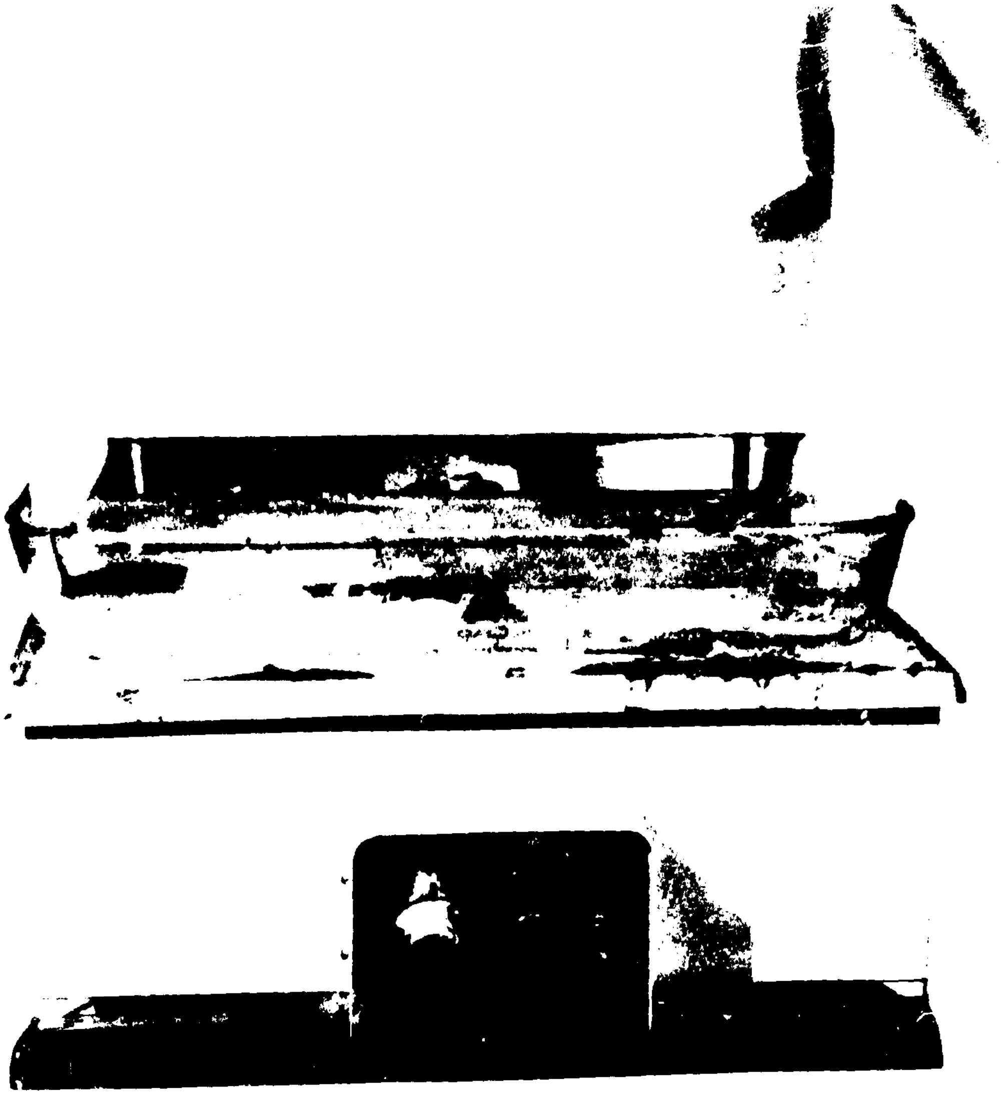

FIGURE Dip Coating of Fabrics

Chemglaze Z004. This is a 35 per cent solids polyurethane coating. Dip coating was the same as that of the B-602 material except that no dilution was necessary and the substrates normally required two coats.

Adiprene L-100. This extremely thick molasses-like polyether liquid polymer is normally cured with a diamine. First attempts at coating with this polymer indicated that its short potlife (3-10 minutes), when the recommended diamine curative was used, would not permit the fabrication of the quantity of coated fabric material required for testing purposes. Also, the coatings were frequently lumpy. The Adiprene L-100 was dip coated in the same manner as the B-602 material and with the same solvent.

An attempt was made to hasten the "moisture" cure-time of the Adiprene and Vibrathane materials with the addition of 0.05 to 0.1 parts of adipic acid. The addition of the adipic acid appeared to decrease the cure time, but the coatings formed contained an excessive amount of bubbles.

Estane 5714 F-1. This is a solution grade polyether urethane resin soluble in a variety of solvents including ketones, toluene, tetrahydrofuran (THF), dimethylformamide (DMF), and dimethylsulfoxide (DMSO). The drying rates of the 5714 F-1 resin solutions are dependent upon the solvent used. An approximately 10 per cent solids solution of 5714 F-1 in 70/30 acetone/THF gave the best solution viscosity for dip coating. All substrates received three coats applied in the same manner used with B-602 material except that only one hour of drying time was required between coats.

All resinous coatings were clear and semiglossy. In an effort to obtain ultraviolet light-resistant materials, black pigmented coatings were prepared by addition of five to ten parts per hundred of a 1:1 combination of a fine thermal (FT) carbon black/trioctylphosphate to the various urethane solutions.

Results of the evaluation of coated fabrics described in the previous year's work and aged for six months outdoors in Panama are also included in this investigation.

The test methods used to evaluate the experimental and control coated fabrics are shown in Table II.

TABLE II

PROPERTIES DETERMINED AND TEST METHODS USED[1]

Property	Method
Weight, oz./sq.yd.	F.T.M.S.* 191, Method 5041
Thickness, Inch	F.T.M.S. 191, Method 5030
Breaking Strength, lb.	F.T.M.S. 191, Method 5102
Abrasion-Resistance	F.T.M.S. 191, Method 5304[2]
Low Temperature Flexibility	[3]
Heat Stability	[4]
Fungus Resistance	F.T.M.S. 191, Method 5760
Ozone Resistance	[5]
Chemical Resistance	[6]
Weathering Resistance	F.T.M.S. 191, Method 5804
Tear Resistance	ASTM Method D1004
Hydrolytic Stability	[7]

*Federal Test Method Standard 191

[1] All testing was performed at 73°F and 50% R.H. (Federal Test Method Standard 406, Section 4) unless otherwise indicated in the applicable test method.

[2] Modified as follows: 240-grit paper, 6-pound load, 3.5 pound tension, 1000 cycles.

[3] Specimens (1 inch by 6 inches) were conditioned for four hours at -67°F and then flexed over a 1/4-inch mandrel.

[4] Temperature, pressure, and dwell time were varied on the impulse and thermal heat sealers as required to obtain proper heat seals.

[5] Specimens (1 inch by 3 inches) were bent and wrapped around 1/16, 1/8, and 1/4 inch rods and exposed in an ozone chamber maintained at 100°F ± 2°F and 50 ± 5 pphm ozone for seven days. Time to first crack was observed under 7-power magnification.

[6] Specimens were 2 inches by 4 inches. Test fluids were MIL-L-46000, Lubricating Oil; TT-S-735, Type II Fuel (60/5/20/15 Iso-Octane/Benzene/Toluene/Xylene); and O-I-503, Type I Insect Repellent. The chemical resistance of the coated fabrics was evaluated as follows: one-half of a specimen was covered with a test fluid and the results were observed after 7 days at 73°F and 50 per cent R.H.

[7] Specimens 1 inch by 4 inches were suspended over 200 milliliters of distilled water in a tightly sealed one-quart jar. The assembly was placed in an oven maintained at 158°F for 30 days.

RESULTS AND DISCUSSION

Substrates

The properties of two woven and two nonwoven fabrics, as received from industry, are listed in Table III. The woven nylon material is similar to the base fabric used in MIL-C-20696. This weight of fabric is strong, relatively easy to coat, and has a good hand (drape-flexibility) Although the woven Betaglass fabric is somewhat less flexible and weaker than the nylon material, it is more resistant to the effects of ultraviolet light than nylon (most noticeable in the cross direction, Table III) The nonwoven materials were selected for investigation because of three important characteristics; they are lightweig t, flexible, and inexpensive. The price range of nonwovens is from 20 to 85 cents per square yard for a 5-ounce standard-weave nylon fabric. The overall properties of the spunbonded Cerex nylon were superior to those of the spunbonded Reemay polyester. However, the resistance to deterioration by ultraviolet light was relatively the same for both fabrics.

Liquid Polymers

The properties of the liquid polymers used to coat the substrates, shown in Table III, are presented in Table IV (unpigmented materials) and Table V (black pigmented materials) The chemical resistance of the coated fabrics is given in Table VI.

The four "liquid" urethane polymers varied widely in viscosity, i e , from the water-thin Chemglaze to the very thick Adiprene (approximately 30 to 20,000 CPS, respectively, at 77°F) and the extremely thick (semisolid) Vibrathanes The 10 per cent solids solution of the Estane resin in Acetone/THF was approximately the same viscosity as the Chemglaze coating material

The resin pickup was greatest for the closely woven Betaglass fabric. This high resin pickup caused the coated Betaglass fabrics to be the stiffest of the materials tested. The thinner, lighter weight Chemglaze coatings ranked next in stiffness. Strike through or penetration of the coating into the fibers was also a contributing factor in the stiffening of Betaglass coated fabrics. However, while all Betaglass coated-fabrics were stiff at room temperature, the coatings could be bent sharply, or folded, at -67°F without cracking. The resin pickup on the remaining three substrates varied dependent upon the liquid

TABLE III

PROPERTIES OF FIBROUS SUBSTRATES

	Nylon A-2951/6	Betaglass GV-4030-01	Cerex 5915	Reemay 2011
Weight, oz./sq.yd.	4.5	6.4	1.6	1.2
Thickness, in.	.014	.014	.006	.009
Machine direction	240	197	22	14
Cross direction	203	201	10	8
Fungus Resistance	← NO GROWTH →			
Low Temperature Flexibility	← NO CRACKING →			
Tear Resistance	NO TEST*	2.0	5.9	1.8
Tests after 150 hours accelerated aging				
Breaking Strength, lb:				
Machine direction	195	175	12	8
Cross direction	105	165	10	4
Visual Examination	NO VISIBLE EFFECT	SLIGHT DARKENING	← NO VISIBLE EFFECT →	

*Individual threads pulled out

Property	L-100				2004			
	Nylon	Beta-glass	Cerex	Reemay	Nylon	Beta-glass	Cerex	Ree
Thickness, in.	.018	.030	.009	.008	.018	.027	.010	.00
Weight, oz./sq. yd.	10.8	19.4	5.6	5.7	10.6	18.4	7.7	6.6
Breaking Strength, lbs.								
Machine Direction	251	207	40	15	251	225	46	18
Cross Direction	118	184	23	15	133	211	28	16
Tear Strength, lbs. Machine Direction (only)	24	24	10.4	7.6	24	24	4.7	2.8
Fungus Resistance	←							
Low Temperature Flexibility	←							
Heat Sealability	←							
Hydrolytic Stability	← NO CRACKING NOT TACKY →				← SLIGHT DISCOLORATION			
Ozone Resistance	← NO CRACKING AFTER 7 DAYS							
Chemical Resistance	← SEE TABLE VI							
Abrasion Resistance, % Wt. Loss	0.59	-	0.47	-	0.62	-	0.56	-
Tests after 150 hours accelerated aging:								
Breaking Strength, lbs. Machine Direction (only)	150	192	30	14	180	197	34	17
Tear Resistance, lbs. Machine Direction (only)	21	23	5.0	3.0	18	25	5.7	2.
Visual observation	color darkened	surface bubbles	color darkened	color darkened	color darkened	surface bubbles	color darkened	col dar

TABLE IV

PROPERTIES OF UNPIGMENTED COATED-FABRICS

14				B602				B605			
- s	Cerex	Reemay	Nylon	Beta-glass	Cerex	Reemay	Nylon	Beta-glass	Cerex	Reemay	Ny
7	.010	.009	.019	.041	.012	.016	.023	.043	.021	.017	.0
4	7.7	6.6	12.8	25.7	7.7	15.3	18.8	24.1	17.4	11.9	10
	46	18	266	190	28	14	266	204	37	30	286
	28	16	105	159	22	14	128	174	32	27	161
	4.7	2.8	28	23	6.3	3.5	26	24	10.4	7.6	26
		NO FUNGAL GROWTH AFTER 28 DAYS									
		NO CRACKING AT -67°F									
		NOT HEAT SEALABLE →									←
DISCOLORATION →			← NO CRACKING NOT TACKY →								←
G AFTER 7 DAYS											
	SEE TABLE VI										
	0.56	-	0.30	-	0.15	-	0.11	-	0.04	-	0.4
	34	17	181	171	28	9	170	179	27	12	143
	5.7	2.7	11.2	28	5.6	2.0	12	20	6.2	1.5	19
e s	color darkened	color darkened	color darkened	surface bubbles	color darkened	color darkened	color darkened	surface bubbles	color darkened	color darkened	colo dark

B605				5714F1				CONTROL MATERIALS	
ylon	Beta-glass	Cerex	Reemay	Nylon	Beta-glass	Cerex	Reemay	Vinyl	Neoprene
.02	.043	.021	.017	.021	.021	.008	.007	.024	.020
18.8	24.1	17.4	11.9	10.3	11.1	4.9	4.4	23	18
266	204	37	30	286	230	35	16	360	315
128	174	32	27	161	147	20	12	215	285
26	24	10.4	7.6	26	20	5.5	3.8	29	30
				→	→	→	→	light growth	no growth
→	→	→	→	→	→	→	→	cracks	no cracks
→	→	→	→	←	HEAT SEALABLE		→	heat sealable	not heat sealable
→	→	→	→	←	SLIGHT DISCOLORATION		→	sl. tacky no cracking	not tacky no cracking
				→	→	→	→	pass	fail
							→	→	→
.11	-	0.04	-	0.47	-	0.24	-	0.67	2.9
70	179	27	12	143	207	25	9	325	295
2	20	6.2	1.5	19	16	4.7	2	26	24
olor rkened	surface bubbles	color darkened	color darkened	color darkened	pinholes color darkened	color darkened	color darkened	color lightens	color lightens

PROPERTI

Property	L-100 Nylon	L-100 Beta-glass	L-100 Cerex	L-100 Reemay	2004 Nylon	2004 Beta-glass	2004 Cerex	2004 Reemay
Thickness, in.	.019	.024	.009	.011	.019	.025	.009	.008
Weight, oz./sq. yd.	10.7	15.1	8.1	8.6	11.7	18.9	8.8	6.6
Breaking Strength, lbs.								
Machine Direction	248	213	37	20	252	197	35	22
Cross Direction	117	157	21	18	110	176	25	14
Tear Strength, lbs. Machine Direction (only)	19.3	21.5	7.0	4.8	25.5	25	4.4	2.6
Fungus Resistance	←							
Low Temperature Flexibility	←							
Heat Sealability	←							NOT HEAT SEA
Hydrolytic Stability	←							
Ozone Resistance	←							
Chemical Resistance	←							
Abrasion Resistance, % Wt. loss	0.21	-	0.06	-	0.51	-	0.32	-
Tests after 150 hrs. accelerated aging:								
Breaking Strength, lbs. Machine Direction (only)	152	215	32	16	171	195	32	15
Tear Resistance, lbs. Machine Direction (only)	15.8	20	5.8	3.0	19.2	19.3	5.0	2.6
Visual observation	surface dulls	surface pin holes	surface dulls	surface dulls	surface dulls	severe pinholing	slight pinnoling	surface dulls

TABLE V

PROPERTIES OF PIGMENTED (BLACK) COATED FABRICS

04			B602				B605				
s	Cerex	Reemay	Nylon	Beta-glass	Cerex	Reemay	Nylon	Beta-glass	Cerex	Reemay	Ny
	.009	.008	.021	.030	.011	.012	.018	.031	.012	.010	.02
	8.8	6.6	15.9	27.4	14.7	12.3	15.0	22.4	10.7	10.3	9.1
	35	22	232	197	33	15	249	223	38	21	248
	25	14	127	121	22	12	112	167	26	20	99
	4.4	2.6	19	19.5	6.3	3.4	21	23.5	9.8	5.2	25.
NO GROWTH AFTER 28 DAYS											
NO CRACKING AT -67°F											
NOT HEAT SEALABLE											
NO CRACKING - NOT TACKY											
NO CRACKING AFTER 7 DAYS											
SEE TABLE VI											
	0.92	-	0.12	-	0.08	-	0.18	-	0.05	-	0.7
	32	15	119	202	31	11	119	179	22	12	161
	5.0	2.6	17.2	17.3	6.5	3.5	14.8	20.5	5.6	2.6	19.
ng	slight pinholing	surface dulls	surface dulls, some pinholing	surface bubbles, pinholing	surface dulls	surface dulls	surface dulls	surface bubbles, some pinholing	surface dulls	surface dulls	surf dull some pinh

B605				5714F1				Control Materials	
Nylon	Beta-glass	Cerex	Reemay	Nylon	Beta-glass	Cerex	Reemay	Vinyl	Neoprene
.018	.031	.012	.010	.020	.023	.008	.008	.024	.020
15.0	22.4	10.7	10.3	9.1	12.6	6.1	3.4	23	18
249	223	38	21	248	194	24	14	360	315
112	167	26	20	99	136	16	9	215	285
21	20.5	9.8	5.2	25.6	18.7	6.0	5.0	29	30
							→	Light growth	No growth
							→	Cracks	No cracks
				← HEAT SEALABLE →				Heat sealable Sl.tacky	Not heat sealable Not tacky
							→	No cracking	no cracking
							→	Pass	Fail
									→
0.18	-	0.05	-	0.71	-	0.67	-	0.67	2.9
119	179	22	12	161	207	26	10	325	295
14.8	20.5	5.6	2.6	19.6	15.3	5.6	2.8	26	24
surface dulls	surface bubbles, some pinholing	surface dulls	surface dulls	surface dulls, some pinholing	surface pinholes	surface dulls	surface dulls	color lightens	color lightens

polymer used; however, the Estane coatings were generally heavier on the wovens and lighter on the nonwoven fabrics.

The substrate breaking strength was not always increased by application of liquid polymer coatings (Tables IV and V). Almost all of the coated fabrics made with woven substrates had significantly lower cross direction breaking strength. Some loss in strength may be due to variations in the coatings or cures, or due to deterioration by solvents used to dilute the polymers. However, the applied coating increased, significantly, the breaking strength of the coated fabrics made from the nonwoven substrates.

The tear strength of the laboratory-prepared, woven coated-fabrics was similar to that of the commercial controls made by spread or roller systems. Several attempts were made to decrease the penetration of the coating into the fabric and to increase the tearing strength. A base coat (tie-coat) of bis(aminomethyl)cyclohexane in methyl chloride was applied to fabric strips and, while the base coat was still slightly wet, a thin coating of liquid polymer was applied. The coating was dry in approximately one hour, but was very stiff and tear strength was not improved. In a second experiment, a thin coating of a liquid polymer was applied to fabric substrates that were then cured in an atmosphere of sym-dimethyl-ethylenediamine. With this treatment, the coatings were so rapidly cured that they became rough and lumpy. Again, tear strength was not improved. In general, the tear strength of the nonwovens was not significantly improved by application of polymer coatings.

All test materials were fungus- and ozone-resistant, and stiff at -67°F. The vinyl control supported light fungal growth and cracked badly when bent around a one-fourth-inch mandrel at -67°F. The neoprene control cracked badly after one day's exposure to ozone.

Only the coated fabrics made from the thermoplastic Estane material were heat sealable. Several attempts were made to coat the thermosetting materials with a thermoplastic resin to obtain heat-sealable materials. The thermoplastic overcoating was only a borderline success. While the coated fabric thus formed was heat sealable, the adhesion between the thermoset and thermoplastic layers was poor. As indicated in Tables IV and V, the vinyl control was heat sealable.

Since many coated-fabrics require extended use in an outdoor environment, hydrolytic stability is an important requirement. At this time, no standard procedure is available for testing coated fabrics for hydrolytic stability.[5] The poor resistance to hydrolysis of polyester urethanes is well documented.[6,7] However, none of the test coatings, including the polyester, became cracked or tacky at the end of the 30-day hydrolysis test (Tables IV and V). Current hydrolytic stability tests for solid rubbers that use a specified loss in stress-strain properties or cracking of stressed specimens as rejection criteria are not adaptable to coated fabrics since the high strength of the coated fabric substrate usually detracts from the value of such testing.

In general, the test coatings were superior in abrasion resistance to the vinyl and neoprene control materials. Both woven and nonwoven base materials were tested for abrasion resistance to determine if the flexibility and smoothness of the substrates would affect the abrasion resistance of the coatings. With the exception of the black pigmented Chemglaze coating, the nonwoven fabric-based coated fabrics had the greater abrasion resistance (Tables IV and V). The latter fabrics are also smoother and more flexible than the woven coated-fabrics.

The insect repellent had a severe effect on the Estane coated-fabrics and on the vinyl control (Table VI). Note that only 2 or 3 drops of the insect repellent were required to cover one-half of each test specimen. Neither the hydrocarbon fuel nor the lubricating oil had any serious effect on the various coated-fabrics.

The breaking-strength loss after accelerated aging was most severe on those coated fabrics containing a woven nylon substrate, i.e., bubbles or pockmarks were evident on some of the coating surfaces. This was true in both the nonpigmented and the pigmented materials. Betaglass based materials were the most resistant to the effects of accelerated aging. Tear strength after accelerated aging varied, possibly, because of further curing by the moisture sensitive materials.

The results obtained on materials aged for six months in Panama are indicated in Table VII. Results indicate that open-sunlight aging had the most severe effect on the laboratory-prepared materials, while the control materials improved somewhat in breaking strength. As shown in the table, three of the laboratory-prepared coated fabrics could

TABLE VI

CHEMICAL RESISTANCE OF UNPIGMENTED AND BL

Chemical	Control Neoprene/ Nylon	Control Vinyl/ Nylon	L-100/ Nylon	L-100/ Cerex	Z004/ Nylon	Z004/ Cerex	
					UNPIGMENTED COATINGS		
MIL-L-46000 Lubricating Oil	Very pronounced curling & twisting	No apparent effect	Sl. curling sl. staining	Sl. twisting, not tacky	Some yellow staining, not tacky	Some yellow staining, not tacky	S s n
O-I-503 Insect Repellent	Slight curling, not tacky	Specimens curl, coating disintegrates	Sl. curling, not tacky	Great deal of curling, not tacky	Sl. curling, very tacky	Slight curling, very tacky	N e
TT-S-735, Type II Hydrocarbon Fuel	No apparent effect	No apparent effect	Great deal of curling, not tacky	Great deal of curling, not tacky	No apparent effect	No apparent effect	S c n
					BLACK PIGMENTED COATINGS		
MIL-L-46000 Lubricating Oil	See above	See above	No change	No change	No change	Slight curling	Sl s d
O-I-503 Insect Repellent	See above	See above	Surface dulls, moderately tacky	Slightly wrinkled, slightly tacky	Slight curling, slightly tacky	Severe curling, not tacky	Sl c s d s t
TT-S-735, Type II Hydrocarbon Fuel	See above	See above	No change	No change	No change	Severe curling, not tacky	Sl t

TABLE VI

TANCE OF UNPIGMENTED AND BLACK PIGMENTED COATINGS

Z004/ Nylon	Z004/ Cerex	B602/ Nylon	B602/ Cerex	B605/ Nylon	B605/ Cerex	5714F1/ Nylon	5714F1/ Cerex
UNPIGMENTED COATINGS							
ome yellow taining, ot tacky	Some yellow staining, not tacky	Some yellow staining, not tacky	Some yellow staining, pronounced curling and twisting	Some yellow staining, slight curling	Slight yellow stain, slight curling	No apparent effect	Slight yellow stain, slight curling
l. curling, ery tacky	Slight curling, very tacky	No apparent effect	Slight curling, very slightly tacky	Slight curling, very slightly tacky	Slight curling, very slightly tacky	Slight curling very tacky	Slight curling, very tacky
No apparent effect	No apparent effect	Slight curling, not tacky	Slight curling, not tacky	No apparent effect	No apparent effect	No apparent effect	Slight curling not tacky
BLACK PIGMENTED COATINGS							
No change	Slight curling	Slight surface dulling	Slight curling, slight dulling	Slight dulling	Slight curling, slight dulling	Slight dulling	Slight dulling
Slight curling, slightly tacky	Severe curling, not tacky	Slight curling, slight dulling, slightly tacky	Slight curling, slightly tacky	Severe curling, some loss of coating, very tacky	Slight curling, extemely tacky	Complete loss of coating, extemely tacky	Complete loss of coating, extremely tacky
o change	Severe curling, not tacky	Slightly tacky	No change	No change	Slight curling, slight dulling	Slight dulling	Slight dulling

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TABLE VII

COATED FABRICS AGED 6 MO

Property	Neoprene/ Nylon Control			Vinyl/ Nylon Control			Adiprene L-100/ Nylon			Adiprene L-100/ Lantuck			Chemglaze Z001/ Nylon			Chemgl Z001/ Lantuc	
	O*	OS	RF	O	OS	RF	O	OS	RF	O	OS	RF	O	OS	RF	O	O
Breaking Strength, lbs., M D only	293	285	342	286	355	370	246	40	222	29	3.8	18.5	244	85	235	23	N
Thickness, inch	.021	.021	.021	.024	.025	.025	.019	.019	.020	.022	.020	.022	.018	.017	.018	.014	N
Presence of fungus (Visual)	-	No	No	-	No	Yes	-	No	Yes	-	No	Yes	-	No	Yes	-	Ye
Delamination (Visual)	← NO DELAMINATION																
Color change (Visual)**	-	2	5	-	2	5,7	-	3,4	3,4	-	3,4	6,7	-	3,4	3,4	-	3,

*O - Original property value
OS - Open Sunshine aging in Panama
RF - Rain Forest aging in Panama
NT - No Test
**1. - No change in coating
2. - Coating color lightened
3. - Coating brittle
4. - Slight darkening of coating
5. - Moderate darkening of coating
6. - Severe darkening of coating
7. - Coating mottled (probably due to fungus)

TABLE VII

AGE 6 MONTHS IN PANAMA

	Chemglaze 2001/ Lantuck			Ricon 429/ Nylon			Ricon 429/ Lantuck			RTV Silicone/ Nylon			RTV Silicone/ Lantuck			Vibrathane B605/ Nylon			Vibrathane B605/ Lantuck			
	O	OS	RF	O	OS	RF	O	OS	RF	O	OS	RF	O	OS	RF	O	OS	RF	O	OS	RF	
5	23	NT	10.5	286	160	145	26	NT	NT	160	103	110	11	3.7	6.0	240	67	210	23	6.6	13.3	
8	.014	NT	.013	.023	.023	.022	.019	.022	NT	.018	.018	.019	.022	.022	.024	.019	.018	.018	.021	.016	.019	
s	-	Yes	Yes	-	No	Yes	-	No	Yes	-	No	Yes	-	No	Yes	-	No	Yes	-	No	Yes	
ION →																						
4	-	3,6	3,6, 7	-	3,4	3,4	-	3,5	3,6, 7	-	1	4,7	-	4	6,7	-	3,4	3,4	-	6	6,7	

not be tested due to extreme deterioration. All materials except the neoprene control showed evidence of fungus (debris, some viable) when returned from Panama.

In general, coated fabrics made from liquid urethane polymers are equal to or better than the currently available neoprene and vinyl materials, especially with respect to abrasion and ozone resistance, and low-temperature performance. However, liquid urethane polymers are not yet developed at the point in which they can be utilized without solvent dilution or special processing equipment. Thus, an economic disadvantage exists between the currently used neoprene and vinyl coated fabrics, and liquid urethane coated fabrics.

CONCLUSIONS

1. The viscosity of all liquid polymers with the exception of Chemglaze Z004 had to be reduced to approximately 50 per cent solids to facilitate any type of coating.

2. In almost all instances, the cross-direction breaking strength of the coated substrates was lower than that of the uncoated substrate. This may be due to entrapment of the load-bearing fibers that results in a type of brittleness in the fabric's cross direction.

3. All control and experimental urethane-coated fabrics (including one polyester material) were hydrolytically stable under the test conditions used.

4. Generally, the experimental coated-fabrics were superior to the commercial controls in abrasion resistance.

5. The commercial vinyl material and the Estane polyurethane coated-fabric were subject to severe deterioration by O-I-503 insect repellent.

6. Six months' open-sunlight aging had a more deteriorating effect on laboratory-prepared coated fabrics than the rain-forest aging.

7. The best combination of breaking and tear strength and resistance to accelerated aging was obtained with either a pigmented or nonpigmented liquid polyurethane coated on a Betaglass/Dynel substrate. These experimental materials had abrasion resistance equal to or better than that of the vinyl control and two to three times better than that of the neoprene control. The black pigmented material suffered

little or no loss in tear strength after accelerated aging while the control materials lost 10 to 20 per cent in tear strength.

RECOMMENDATIONS

1. Studies on new liquid polymers, tie-coatings, and substrates should be continued to achieve improvements in future development of fabric coatings in weapon accessories.

2. A hydrolytic stability test should be developed specifically for coated fabrics.

LITERATURE CITED

1. Kirk-Othmer, Encyclopedia of Chemical Technology, Volume 5, John Wiley (New York), 1968.

2. Encyclopedia of Polymer Science and Technology, Volume 6, Interscience (New York), 1968.

3. Garland, W. F., "Liquid Polymers as Coatings for Improved Coated Fabrics," U. S. Army Weapons Command, Weapons Laboratory at Rock Island, Technical Report RE-TR-71-51, July 1971.

4. Military Specification, MIL-C-20696, Cloth, Coated, Nylon, Waterproof.

5. Saunders, A. C., "Nonwoven Materials as Improved Substrates for Coated Fabrics," U. S. Army Weapons Command, Science and Technology Laboratory, Technical Report RE-TR-70-162, November 1970.

6. Testroet, F. B., "Hydrolytic Stability of Commercial Polyurethane Vulcanizates," U. S. Army Weapons Command, Science and Technology Laboratory, Technical Report 68-3276, November 1968.

7. Testroet, F. B., "Performance of Urethane Vulcanizates in Environments of High Humidity," Rock Island Arsenal Laboratory, Technical Report 63-2808, August 1963.

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13. ABSTRACT

Results are presented for the second years' effort of a two-year program initiated by personnel of the Research Directorate, Weapons Laboratory, WECOM concerning the use of liquid polymers as coatings for fibrous and nonfibrous substrates to provide improved weapon accessories such as gun covers and cleaning kit packets. Both pigmented and nonpigmented coatings were investigated. Application of solvent-diluted polymer coatings to woven substrates caused a significant loss in cross-direction breaking strength. Base or tie coats (consisting of liquid diamines applied to the substrate prior to application of liquid polymers) did not significantly improve the tear strength of the coated fabrics made from either woven or nonwoven substrates. Except for the Estane solution coating, the polyurethane liquid polymers were generally resistant to a hydrocarbon fuel, lubricating oil, and insect repellent. Six months' open sunlight aging in Panama was generally more severe than rain forest aging on both the pigmented and nonpigmented coated fabrics. The best combination of breaking and tear strength and resistance to accelerated aging was obtained with either a pigmented or nonpigmented liquid polyurethane coated on a Betaglass/Dynel substrate. These experimental materials had abrasion resistance equal to or better than that of the vinyl control and two to three times better than that of the neoprene control. The black pigmented material suffered little or no loss in tear strength after accelerated aging while the control materials lost 10 to 20 per cent in tear strength. (U) (Garland, William F.)

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