

A New Castable Elastomer Potting Material: a Replacement for EN-7

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GOAL

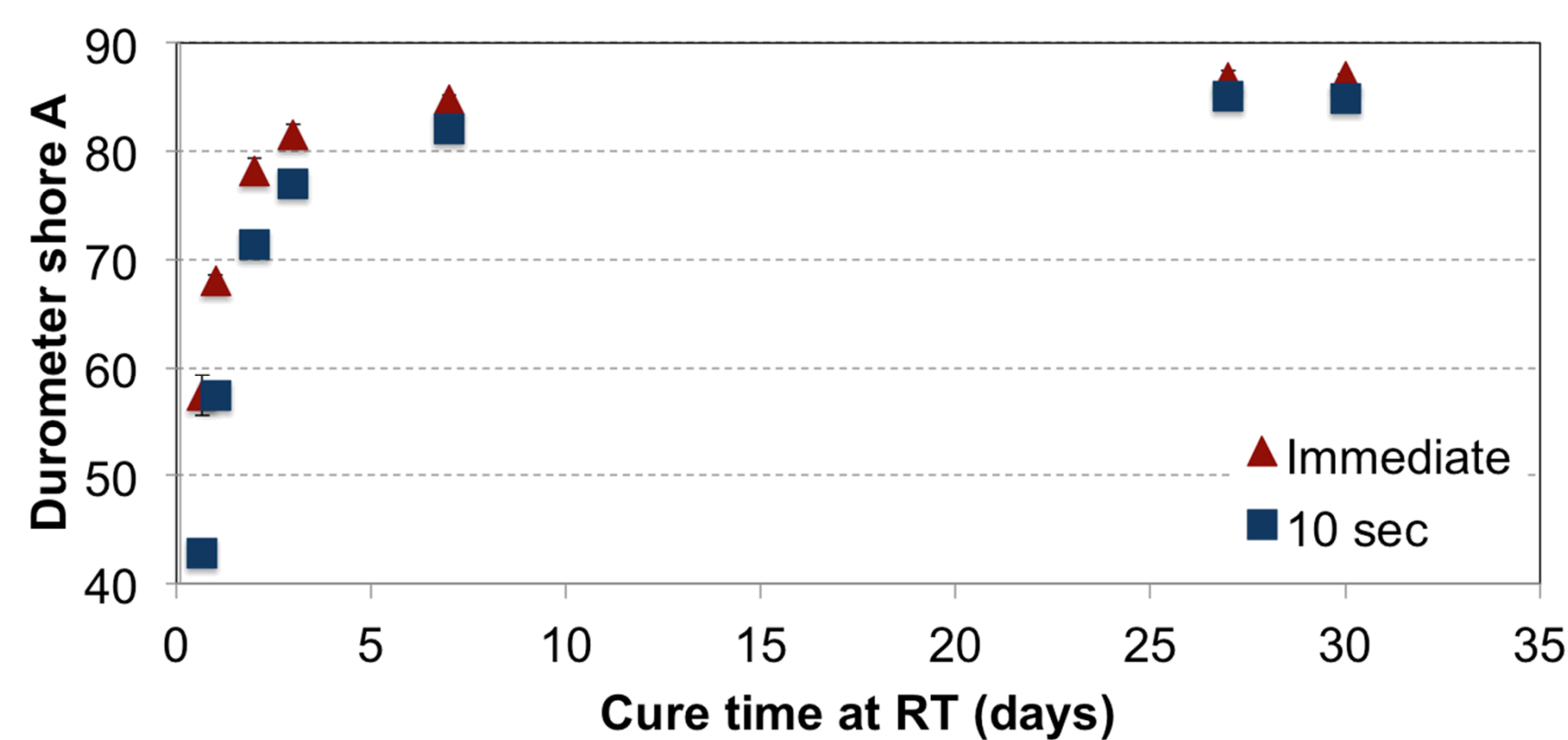
Polyurethane elastomers are specified by SNL for potting of cables and connectors to provide mechanical integrity to solder joints and wires. Various formulations have been used over the years, each with shortcomings: carcinogenic materials, complicated processing, performance under high voltage. Conathane EN-7 (Cytec) meets all of the requirements, but contains toluene diisocyanate (TDI), a suspect carcinogen and chemical sensitizer. Many years have been spent to find a replacement, with little success.

APPROACH

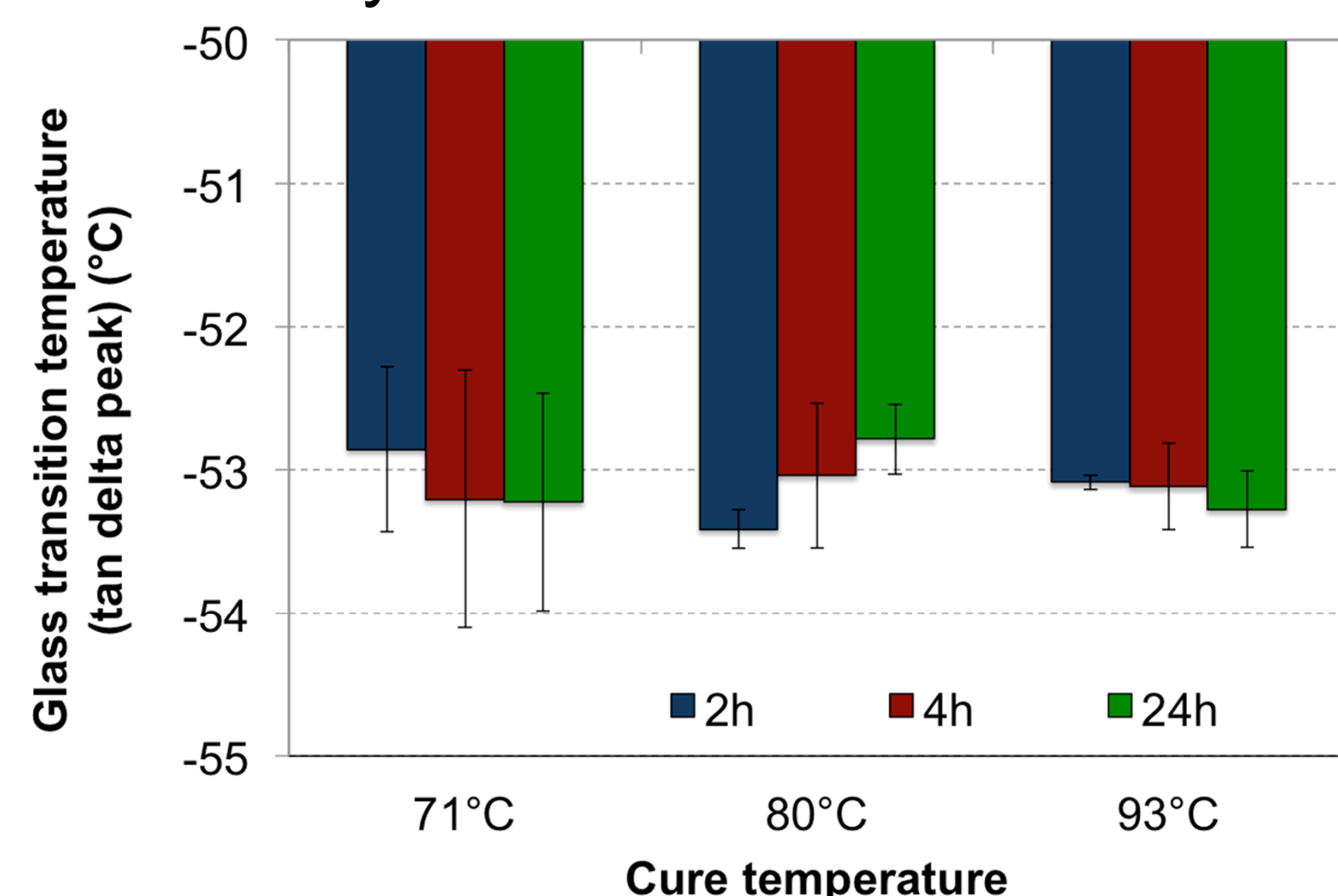
We started with Arathane 5753(LV) (Huntsman), a commercial polyurethane elastomer that has been used in aerospace applications and contains methylene diphenyl diisocyanate (MDI), not TDI. To stiffen the material from its original hardness of Shore A 55-60, a short chain diol was added, 2-ethyl-1,3-hexanediol (DEH). The new formulation, now called Arathane 5753 HVB, has both favorable processing characteristics and electrical properties matching EN-7.

CURE STUDY

Arathane 5753 HVB completes the final cross-linking slowly, acceptable for gentle handling after 24 hours and fully cured after 7 days at RT.



Accelerated cure schedules were evaluated in several combinations, with the conclusion that the material is fully cured after 2 hours at 71°C.



MATERIAL PROPERTIES

Thermal

The glass transition temperature and the CTE determine the use temperature range for the material.

Property	EN-7	Arathane 5753 HVB
T _g (°C)	-63	-61
CTE (20°C, ppm/°C)	212	176

Mechanical

These properties predict how the material will perform its function of protecting solder joints and wires.

Property	EN-7	Arathane 5753 HVB
Hardness (Shore A)	94	90
Tensile strength (MPa)	8	12
Tear strength (MPa)	3.0	1.6
Peak shear stress (Al) (MPa)	7.4	7.3
Peak shear stress (PEEK) (MPa)	5.3	2.3

Electrical

The material's resistance to electrical current becomes especially important when potting high-voltage cables.

Property	EN-7	Arathane 5753 HVB
Breakdown strength (kV/mm)	30.0	29.1
Volume resistivity (ohm-cm x10 ¹⁶)	1.01	2.14

Compatibility

The reaction between materials in a sealed system will determine its long-term stability during deployment.

Property	EN-7	Arathane 5753 HVB
Outgassing (TML)	0.25%	0.66%
Outgassing (CVCM)	0.013%	0.006%
Moisture absorption	0.65%	0.47%

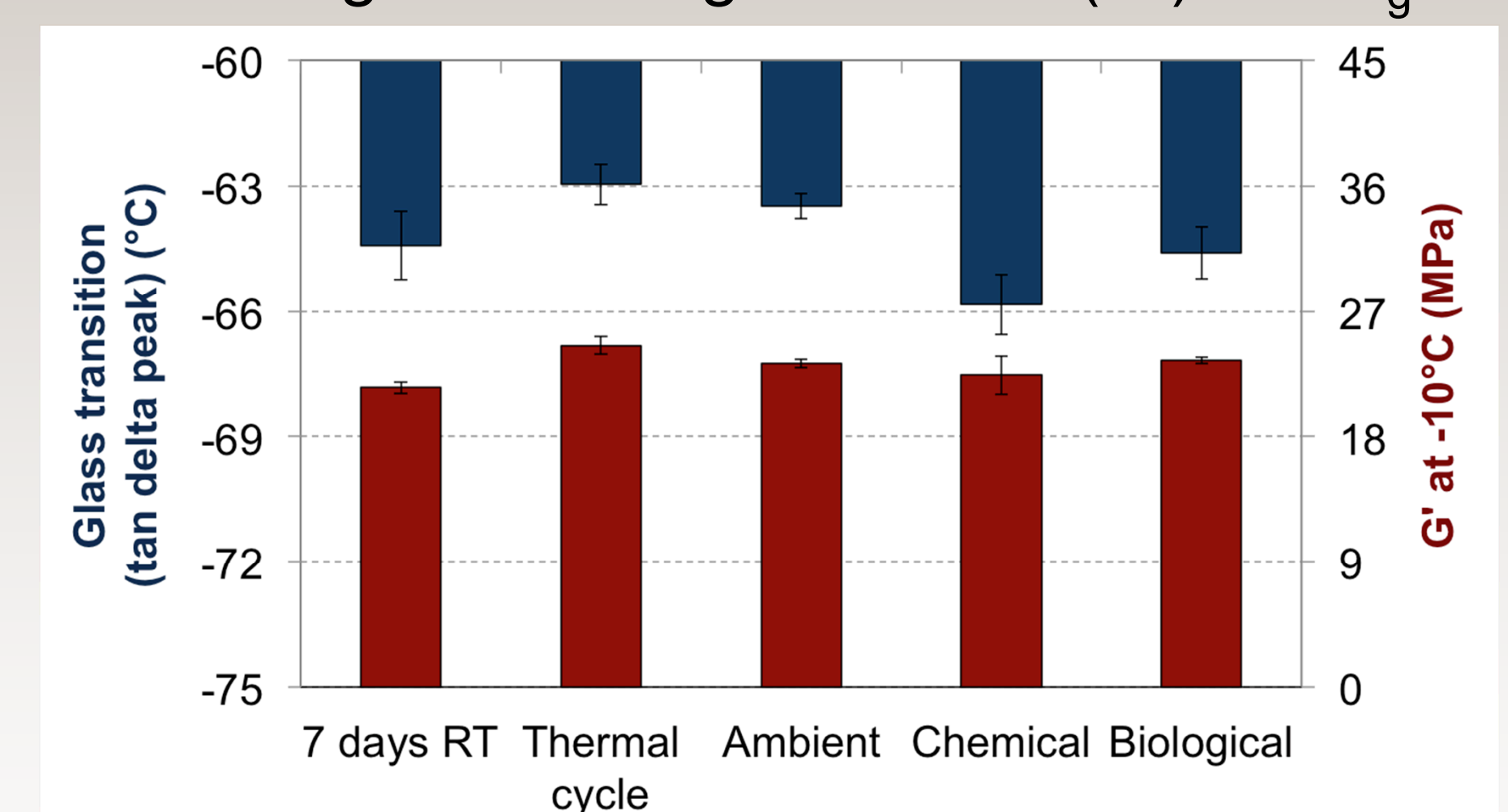
Processing

Easier processing conditions and longer pot life will lead to better results, particularly at external vendors.

Property	EN-7	Arathane 5753 HVB
Pot life (minutes)	10-15	25-30
Initial mix viscosity (cP)	18000	5000
Preheat requirements	93°C	71°C
Minimum cure req.	71°C 24h	71°C 2h
Cure shrinkage	2.3%	1.7%

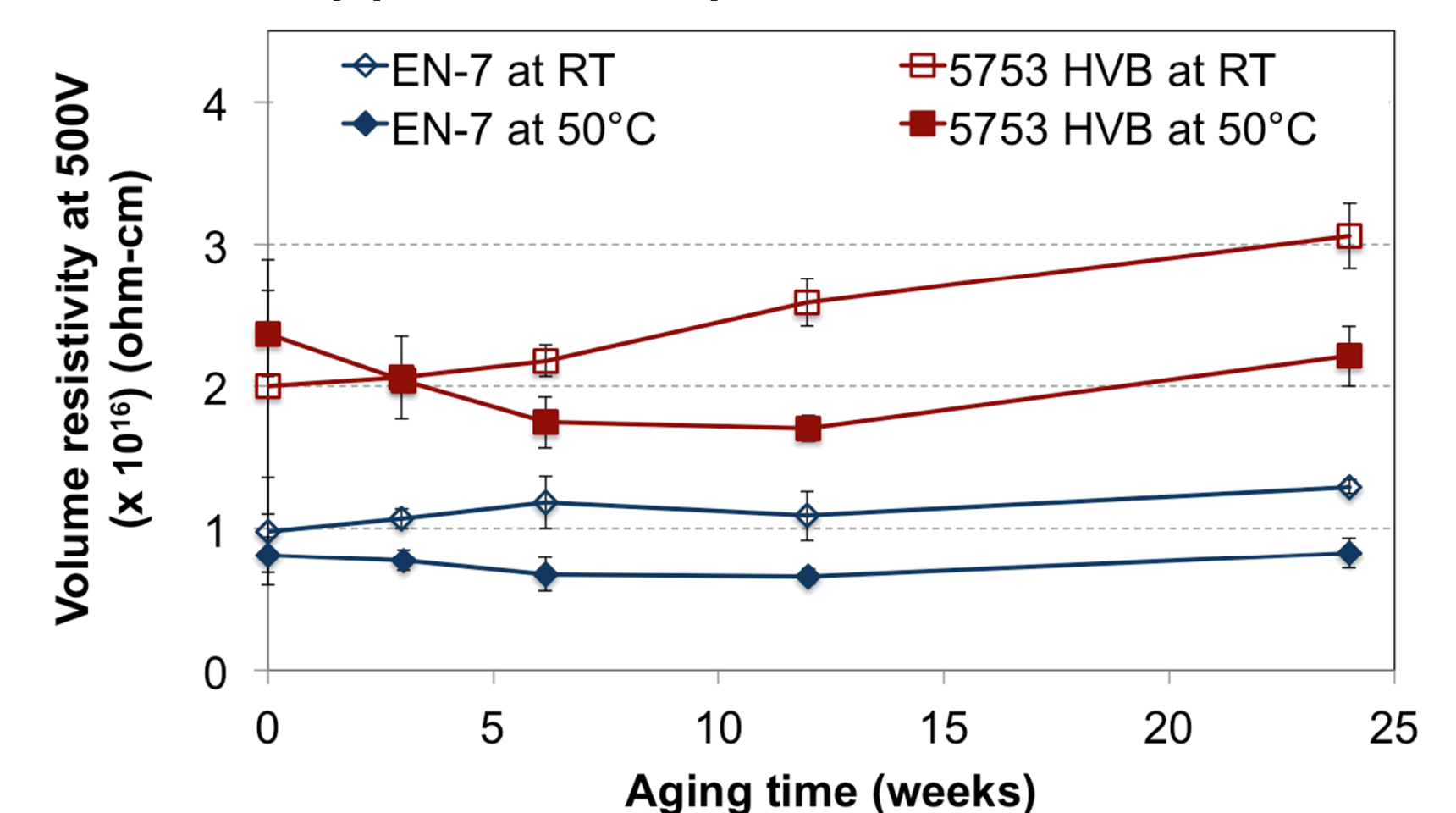
COMPATIBILITY TESTING

Arathane 5753 HVB was aged under several different environments for 6 months, with only small changes to storage modulus (G') and T_g.



AGING STUDY

A study of Arathane 5753 HVB and EN-7 is nearly concluded, looking at lap shear, volume resistivity, T_g/modulus, and other properties over 48 weeks at 3 temperatures. The performance of 5753 HVB appears comparable to EN-7 thus far.



IMPACT

Arathane 5753 HVB shows promise as a replacement for EN-7.

- Liquid constituents, free of TDI
- Commercially available
- High voltage breakdown strength is comparable to EN-7
- Passes NASA outgassing req.

This new encapsulating material is currently being evaluated for incorporation into several components in different weapon systems.

- Selected for potting of JTAM connectors on B61-3,4,7,11 JTA
- W88 component