BOMAR® OLIGOMERS

Heat Aging Study

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A heat aging study carried out by Bomar provides information for how a wide variety of oligomers react to exposure to high temperatures over time. In this study, the cured material was subjected to high heat for varying periods of time and several tests were performed to determine how increased temperatures affect oligomers. Tensile retention, retention of toughness, change in modulus, and change in color provide insight into the heat resistance capabilities of Bomar products.

Applications

Numerous oligomer applications require high heat resistance where a UV–cured part will be exposed to extreme temperatures. Some adhesive and coating applications require heat stability at temperatures ranging from 100–180°C for periods up to 14 days. Exceptional heat resistant requirements appear in the following industries: adhesives, aviation, under hood automotive, electronics, high temperature coatings, and hot stamp foil printing.

Test Conditions

Bomar® oligomers were diluted with 30% IBOA and photoinitiator was added. These formulations were cast onto glass plates and cured to form tensile strips; each 10 mils (250 microns) thick. The tensile strips were placed in both 100°C and 180°C ovens for varying lengths of time. After cooling, the tensile strips are evaluated on an Instron tensile tester with a jaw gap of 2 inches. Data was not collected at hours one and four under 100°C conditions because for shorter amounts of time, the sample will remain more temperature stable

Tensile Retention

Tensile strength is the stress a material can endure before it breaks. Tensile retention is how well these products retain tensile strength when exposed to extreme temperatures. For each oligomer, tensile strips were prepared and placed in either a 100°C or 180°C oven for increasing periods. At each time interval, strips were tested and analyzed on an Instron tensile tester. Below, the top performing oligomer dilution data is presented. As temperatures increase, heat stability of materials decreases, excluding BR–641D and BR–771F, which both increased in tensile retention as the 14–day period concluded.

Retention of Toughness

In this study, retention of toughness is measured using an area under the curve calculation on the stress and strain curve presented by the Instron. Below are recommendations based on loss or retention of toughness for oligomer dilutions aged for 1, 7, and 14 days at 100°C. Each oligomer dilution offered an increase in retention of toughness over the 14–day period.

Change in Modulus

Modulus measurements are calculated during the collection of tensile data on the stress and strain curve. Elastic modulus quantifies the amount of energy needed to deform an object. The steepest portion of the slope on the stress and strain curve represents Young's modulus. The table below depicts changes in modulus as they occur over time at 100°C. The change in modulus decreased across each oligomer dilution showing that the energy required to deform the material will decrease as heat exposure increases for this set of products.

Table 1. Tensile retention of oligomers over a period of 14 days at 100°C

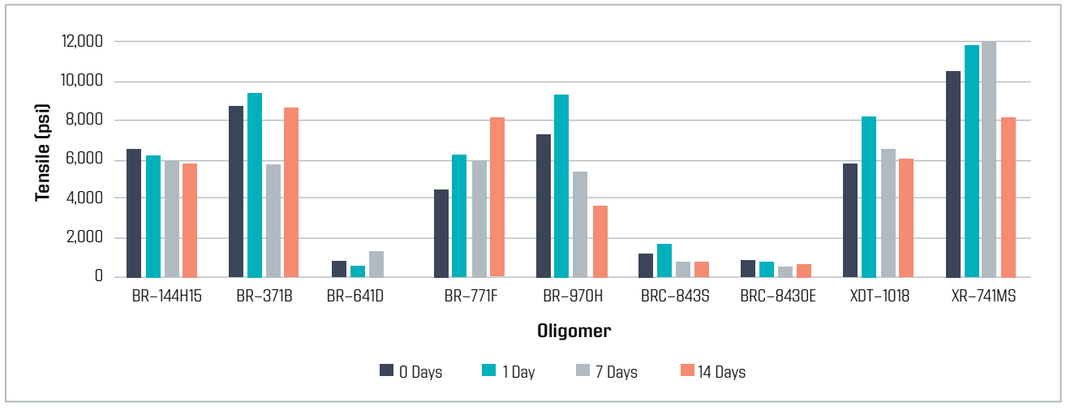


Table 2. Toughness retention of oligomers over a period of 14 days at 100°C

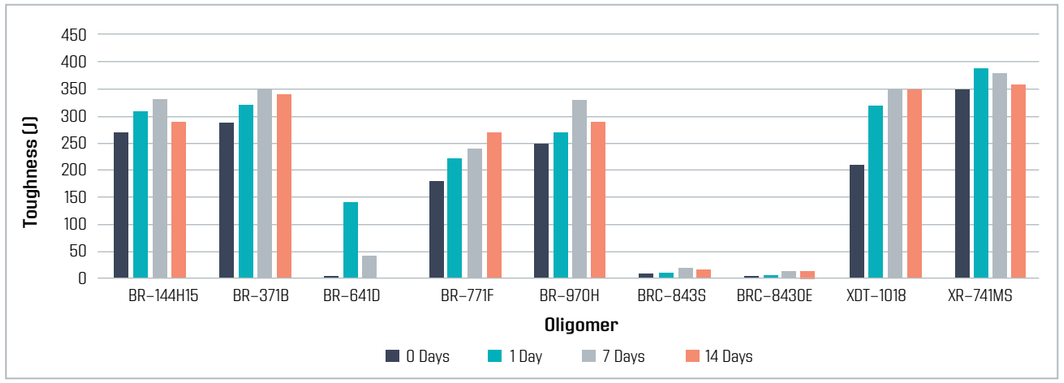
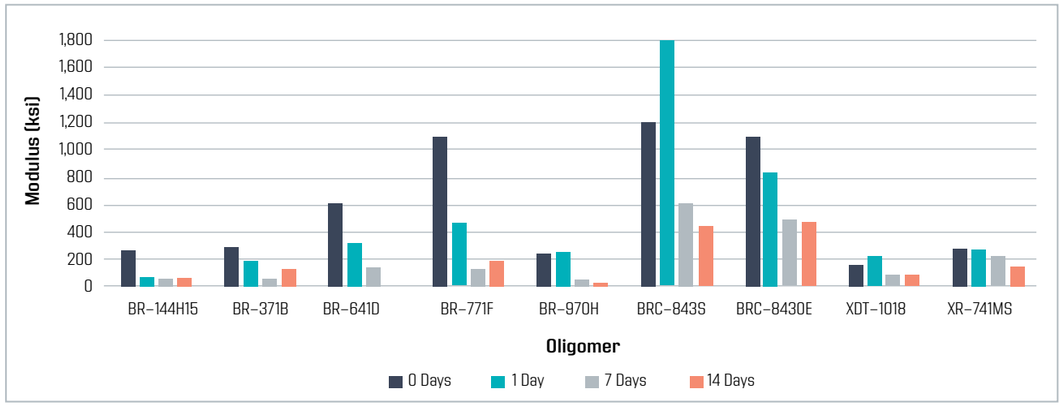


Table 3. Modulus retention of oligomers over a period of 14 days at 100°C



Change in Color

When exposed to high temperatures, any material will most likely undergo color change to some degree. However, several Bomar oligomers maintain less change in color for an extended period of time at 180°C, as seen below. Because Bomar materials are more temperature stable at 100°C, color change was not tested nor reported.

Table 4. Change in color of selected oligomers over a period of 14 days at 100°C

Time (days)	BR-144H15	BR-371B	BR-641D	BR-771F	BR-970H	BRC-843S	BRC-8430E	XDT-1018	XR-741MS
0	1.2	1.4	1.0	1.6	1.6	0.4	0.7	3.0	1.1
1	57.5	50.7	44.6	23.9	23.9	15.9	10.3	52.5	14.5
7	60.2	60.7	61.1	60.0	60.0	38.0	35.9	60.9	41.1
14	61.2	62.0	60.9	61.2	61.2	54.9	53.7	61.0	53.7

Summary Table

Below is the summary of the results of several oligomers exposed to high temperatures, 100°C and 180°C over a period of 7 days and 1 day, respectively.

100°C Heat Aging

Oligomer	7 Days - Based on the Retention of		
	Tensile	Tough-ness	Change in Modulus
BDT-1006	▲	▲	o
BDT-4330	▲	▲	o
BR-1043MB	x	x	++
BR-116	▲	▲	+
BR-144B	▲	▲	o
BR-144H15	▲	▲	o
BR-202	Δ	Δ	++
BR-204	Δ	▲	--
BR-302	▲	Δ	--
BR-371MS	Δ	Δ	o
BR-371S	▲	▲	o
BR-3747AE	▲	▲	+
BR-441BI20	▲	▲	o
BR-541S	x	x	+
BR-543	x	x	--
BR-5825I30	x	Δ	+
BR-582I10	x	x	-
BR-640D	Δ	Δ	++
BR-641D	Δ	Δ	+
BR-641E	▲	▲	+
BR-643	▲	▲	+
BR-7432GB	Δ	Δ	o
BR-771F	▲	Δ	+
BR-930D	Δ	Δ	o
BR-941	▲	▲	o
BR-952	Δ	Δ	-
BR-970BT	▲	Δ	+
BR-970H	Δ	Δ	o
BR-990	▲	▲	++
BRC-4421	▲	Δ	+
BRC-443	Δ	Δ	+
BRC-841	Δ	▲	o
BRC-843	▲	▲	+
BRC-8430E	▲	▲	o
BRC-843S	▲	Δ	-
BRS-14320S	▲	Δ	++
XDT-1018	Δ	▲	o
XR-741MS	Δ	Δ	o

180°C Heat Aging

Oligomer	1 Day - Based on the Retention of			
	Tensile	Tough-ness	Change in Modulus	ΔE vs. White Standard
BDT-1006	F	F	F	8.8
BDT-4330	x	x	+	8.9
BR-1043MB	F	F	F	59.0
BR-116	F	F	F	60.1
BR-144B	F	F	F	54.2
BR-144H15	▲	x	+	57.5
BR-202	F	F	F	56.1
BR-204	F	F	F	59.8
BR-302	Δ	Δ	▲	57.7
BR-371MS	Δ	x	+	52.6
BR-371S	Δ	x	+	50.7
BR-3747AE	x	x	o	61.4
BR-441BI20	F	F	F	24.3
BR-541S	F	F	F	57.1
BR-543	x	x	-	59.4
BR-585I30	F	F	F	56.1
BR-582I10	F	F	F	57.8
BR-640D	x	x	++	23.0
BR-641D	▲	x	++	44.6
BR-641E	▲	x	++	54.5
BR-643	▲	x	++	58.2
BR-7432GB	x	x	+	17.9
BR-771F	▲	x	+	15.9
BR-930D	Δ	▲	o	9.1
BR-941	x	Δ	+	12.8
BR-952	Δ	Δ	o	10.2
BR-970BT	▲	x	+	23.7
BR-970H	▲	Δ	o	23.9
BR-990	▲	Δ	++	20.3
BRC-4421	x	x	o	13.8
BRC-443	Δ	Δ	+	9.2
BRC-841	F	F	F	17.5
BRC-843	x	Δ	+	8.2
BRC-8430E	Δ	Δ	+	10.3
BRC-843S	▲	▲	+	15.9
BRS-14320S	F	F	F	15.2
XDT-1018	▲	Δ	+	52.5
XR-741MS	▲	Δ	0	14.5

▲	Highly Recommended
Δ	Recommended
x	Not Recommended
++	Large increase in Modulus
+	Increase in Modulus
o	Little to no difference in Modulus
–	Decrease in Modulus
––	Large Decrease in Modulus
F	Could not be tested

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