ESSTECH, Inc.

PRODUCT LITERATURE

- Low Shrinkage
- High Conversion
- Enhanced Toughness
- Low Color
- Superior Elongation
- High Hardness

EXOTHANE™
Elastomers

Introduction:

Previous testing revealed that the new EXOTHANE ™ Elastomers demonstrated superior mechanical properties in regards to toughness, hardness, color, tensile strength and percent elongation. Now, additional testing has confirmed that these materials also have low percent volumetric shrinkage, low shrinkage stress and high conversion.

As in the previous studies, the following data was collected by testing our pure EXOTHANE Elastomers alongside the standards, Urethane Dimethacrylate (UDMA) and a 70:30 wt% blend of bisphenol A glycidyl methacrylate and triethylene glycol dimethacrylate (BisGMA:TEGDMA Blend). Each material was formulated with 3% (w/w) Esacure KTO46 as a photoinitiator package. The data that follows focuses on Exothane 8, 9, 26 and 32. Identical testing on Exothane 10 and 32 is pending.

Percent Volumetric Shrinkage:

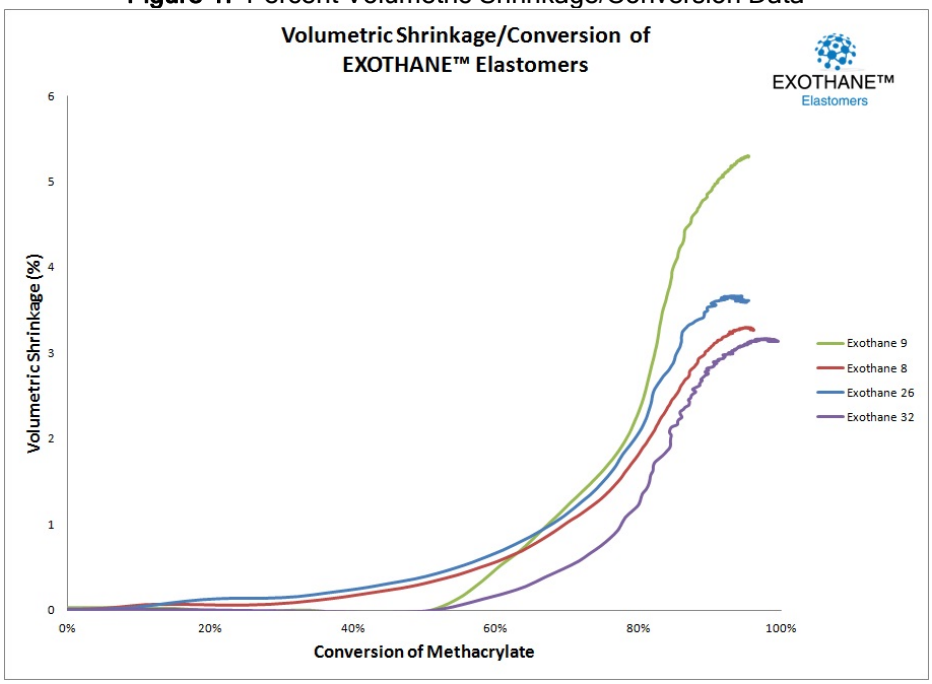
Volumetric shrinkage was measured using a linometer (ACTA). A constant volume of each material was sandwiched between an aluminum disc and a glass cover through which, the curing light irradiated the resin. A mercury arc lamp (Acticure 4000) at an incident irradiance of 20 mW/cm^2 was used to irradiate the materials. Degree of conversion and dynamic volumetric shrinkage were monitored simultaneously.

Volumetric shrinkage values were unobtainable using this process for the UDMA and BisGMA:TEGDMA Blend specimens as each shrunk enough to detach themselves from the glass cover before data could be collected. Separate specimens, half the thickness of the Exothanes specimens, were tested to obtain comparison data. The percent volumetric shrinkage for the UDMA and BisGMA:TEGDMA Blend specimens were 5.8% and 7.1% respectively.

The EXOTHANE Elastomers displayed lower percent volumetric shrinkage while maintaining high conversion values (Figure 1). This is the most ideal scenario for applications requiring low shrinkage and low residual monomers after polymerization. This is also ideal for coating formulations where pull-back and curling are encountered.

Esstech, Inc. ● PO Box 39 ● 48 Powhattan Avenue ● Essington, PA 19029
www.esstechinc.com ● 1-800-245-3800 ● 1-610-521-3800 ● Fax 1-610-521-4600

Figure 1. Percent Volumetric Shrinkage/Conversion Data



Shrinkage Stress:

Shrinkage stress was determined using a tensometer. A 1 mm thick x 6 mm diameter specimen was prepared for each material and photopolymerized through a quartz rod attached to the bottom of the specimen for 10 minutes using the Acticure 4000. Simultaneous real-time NIR conversion data was collected via fiber optic cables during polymerization.

Data for stress development with respect to time is plotted in Figure 2. The data for stress development with regard to conversion are plotted in Figure 3. The average final stress values with the corresponding conversion values obtained are presented in the Summary of Properties (Table 1).

EXOTHANE Elastomers behave counter to the common belief that high conversion values are directly associated with high shrinkage stress upon polymerization. Each of these materials displays conversion over 90% while minimizing shrinkage stress. The standards used in comparison were barely able to reach 75% conversion and had five times the average shrinkage stress.

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Figure 2. Shrinkage Stress/Time Data

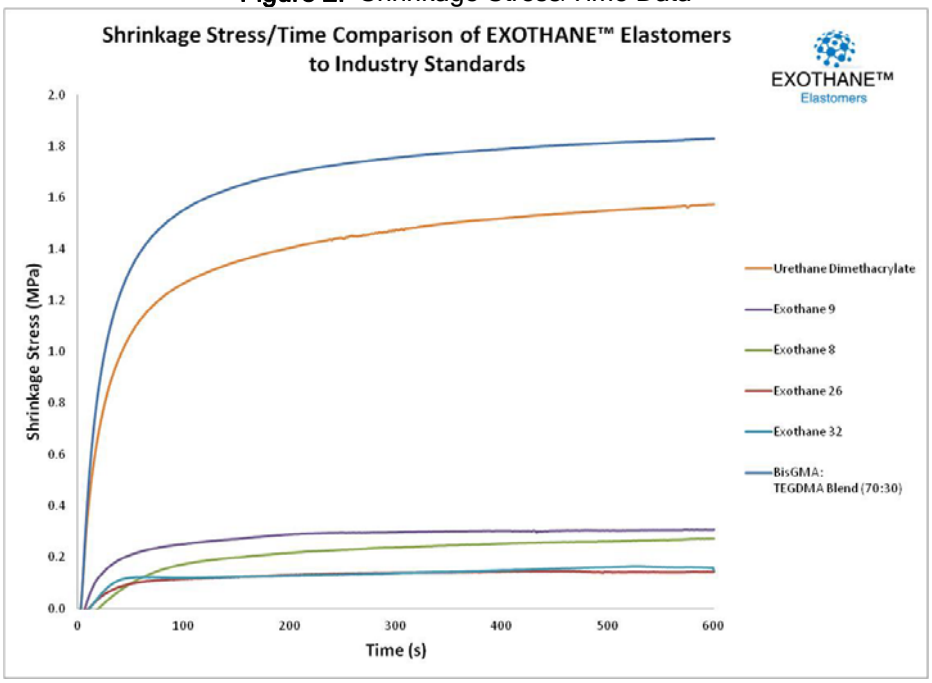
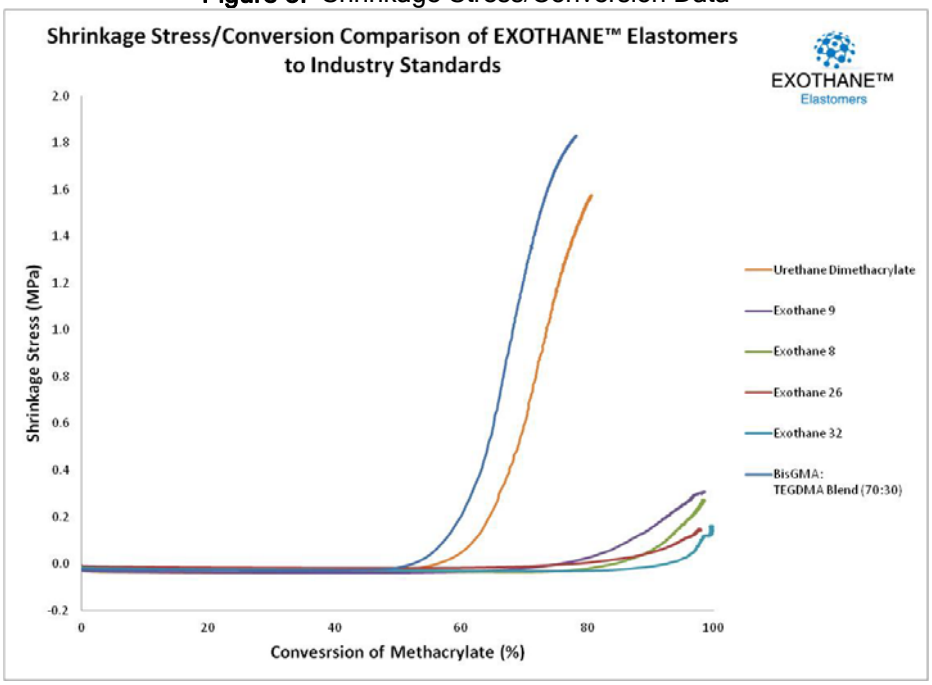


Figure 3. Shrinkage Stress/Conversion Data



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Summary:

Table 1 contains a summary of previous and current test results regarding the EXOTHANE Elastomers. These test results demonstrate the uniqueness of this product line in comparison to the selected standards. Their degree of conversion was consistently higher than UDMA and the BisGMA:TEGDMA Blend with the same photoinitiator package. Both the percent volumetric shrinkage and shrinkage stress were also lower than that of the standards.

Table 1. Summary of Properties

Item Name, Product Code	Toughness at Max Strength (J)	% Conversion	% Volumetric Shrinkage	Average Shrinkage Stress (MPa)	Color (APHA)	Average Hardness Shore D	Tensile Strength (N/mm^2)	% Elongation	Viscosity (PaS)
Urethane Dimethacrylate, X-850-0000	2.05	75.2	5.8	1.6	18	82	56.99	8.99	8.5
Exothane 9, X-726-0000	2.74	96.8	5.3	0.3	21	70	17.03	32.96	1.9
Exothane 10, X-930-0000	15.1	---	---	---	29	73	28.5	64.45	70
Exothane 8, X-891-0000	5.66	94.2	3.3	0.3	30	69	17.31	79.28	30
Exothane 26, X-892-0000	1.3	96.2	3.6	0.1	24	53	5.90	45.69	16
Exothane 24, X-893-0000	0.423	---	---	---	26	93	28.54	4.78	3.7
Exothane 32, X-894-0000	0.585	97.4	3.1	0.2	17	37	2.88	33.77	5.9
BisGMA: TEGDMA Blend (70:30) Reference Only	0.989	71.7	7.1	1.8	14	72	470	6.21	0.41

The potential applications for EXOTHANE Elastomers continue to expand along with ongoing tests. These applications could include, but are not limited to, tougher, low-shrink dental restoratives, low-shrink radiation-curable coatings, photo-curable nail enhancements, rapid prototyping, anaerobic adhesives and more.

Visit our website for additional information regarding these products and others, www.esstechinc.com.

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