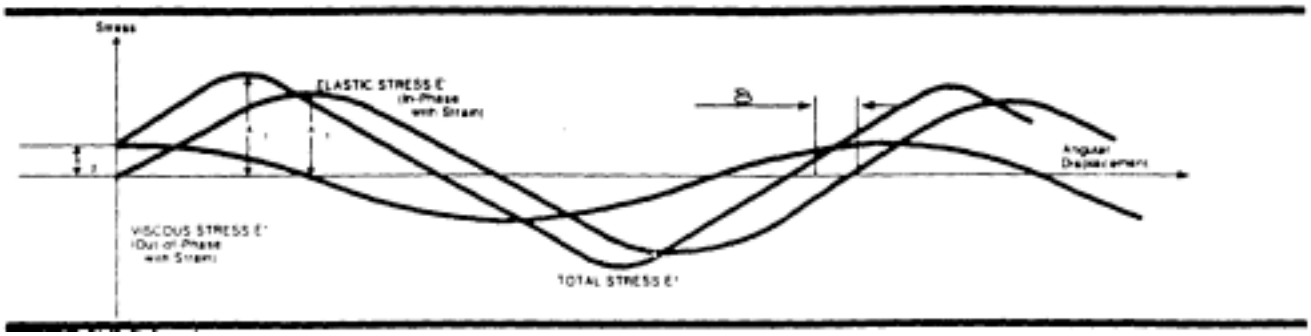


ELASTOMERS

As an Engineering Material
Presented by
D.L. Hertz, Jr.
at
PMA - 1988 Spring Meeting
April 26, 1988 - San Diego, CA

SEALS EASTERN INC.

POLYURETHANES - What Are They?

Block Polymers - consisting of;

a. Flexible chains (polyesters, polyethers) m.w. 1500-3000

b. Rigid segments (aromatic diisocyanates) m.w. 1000-3500

coupled with

c. Short-chain aromatic or aliphatic diamines chain extenders

The polyurethane elastomer has a typical molecular weight estimated to be between 35,000-50,000 for thermoplastics and in excess of 50,000 for millable gums

CLASSES OF POLYURETHANES

1. Millable Gums -

   contain unsaturated sites allowing use of conventional crosslinkers

2. Thermoplastic Gums -

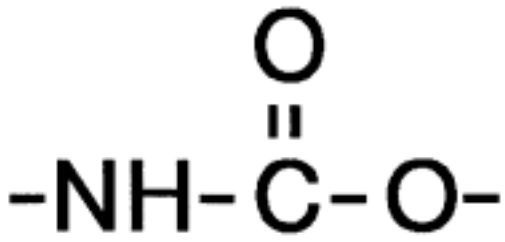
   molded by conventional plastic molding and extrusion equipment

3. Castable Liquids-

   mixed in a liquid state with co-reactants to chain extend and crosslink

COMMON CHARACTERISTICS:

Urethane Linkage



The urethane group has a very high energy of cohesion value - 41.9 kj mol^{-1}

ENERGY OF COHESION - Various Groups*

Group	Energy of Cohesion (kj mol^{-1})
$-CH_2-$	5.15
$-O-$	10.0
$-C(=O)-$	17.4
$-C(=O)-O-$ (ester)	18.0
$-C(=O)-NH-$	27.6
$-NH-C(=O)-O-$	41.9

* Barton - "Handbook of Solubility Parameters"

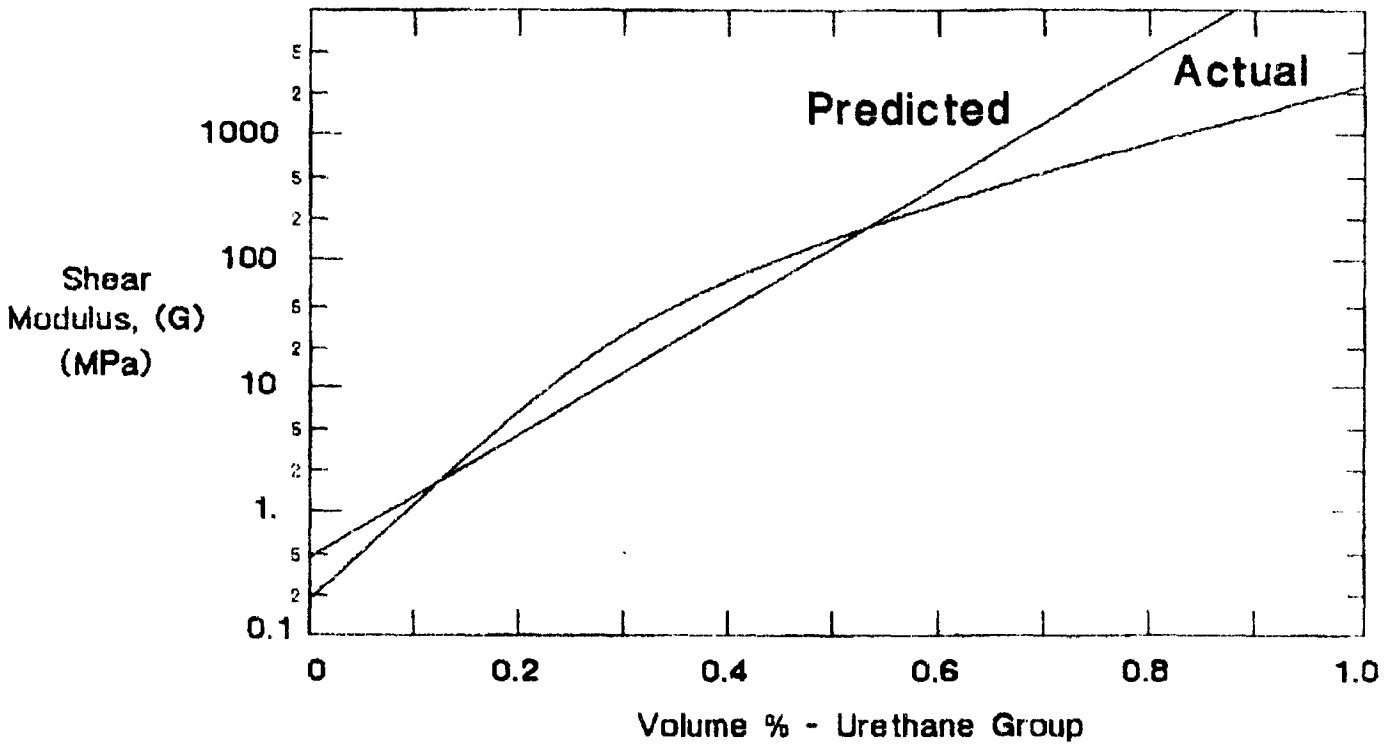
WEAKNESSES OF POLYURETHANES

Segment	Sensitivity
Polyester	Hydrolysis or solvolysis
Polyether	Oxidation or photodegradation
Urethane	Solvolysis in strongly polar fluids
	segmental melting:

77-193 ° C (aliphatic polyurethanes)

180-388 ^{o}C (aromatic polyurethanes)

SHEAR MODULUS G vs. URETHANE CONTENT

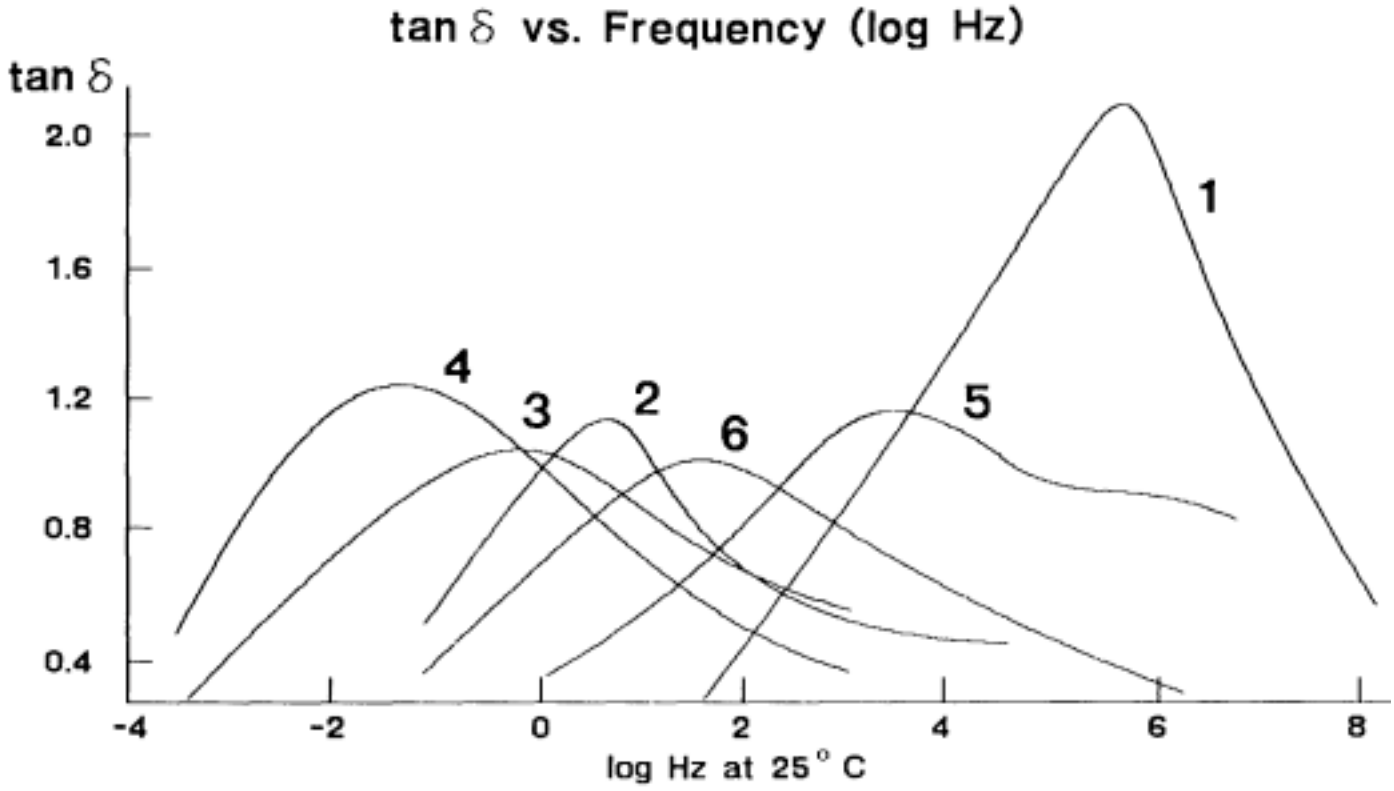


POLYURETHANE DAMPING RANGE*
(tan $\delta \geq 0.5$, 10-1000 Hz)

Polymer	Temperature (°C) from	to	Range ° C
Natural Rubber	-45	-23	22
Polyisobutylene	-47	18	65
Polyurethane No. 1	-34	2	36
Polyurethane No. 2	17	50	33
Polyurethane No. 3	27	69	42
Polyurethane No. 4	34	66	32
Polyurethane No. 5	-35	30	65
Polyurethane No. 6	9	45	36

* "Theory and Practice of Engineering with Rubber" Freakley & Payne (1978)

POLYURETHANE FREQUENCY RESPONSE



(R. Pariser - Dupont, 1963)