



Novel C12TM Chain Extenders for Polyurethanes

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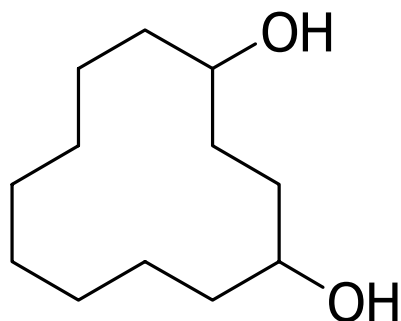
Aisa Sendijarevic & Vahid Sendijarevic - Troy Polymers, Inc.

Introduction

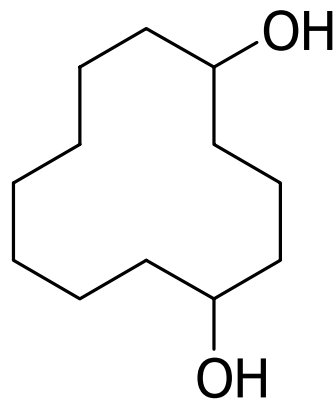
- C12 Intermediates/Specialties group introduced new C12 diol product lines.
- Polyurethane industry a potential outlet.
- Troy Polymers, Inc. working with INVISTA to determine potential of these products as additives in the PU field.
- Split into two studies:
 - Polyester Polyol Study
 - Using C12 LD/1,4-BD & 1,4-BD adipates
 - Chainextender Study
 - Using C12 LD, C12 CD, 1,4-BD & HQEE as chain extenders

C12 Diol Structures

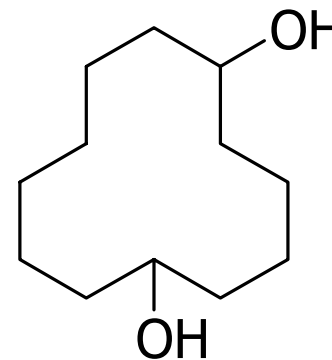
Cyclododecanediol Isomers - C12 CD



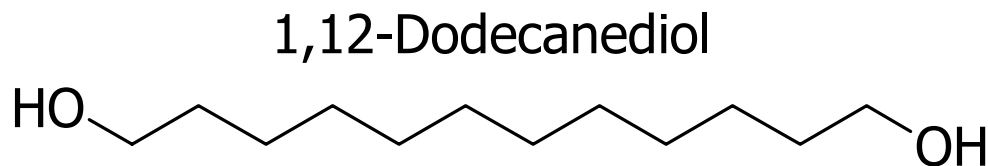
1,4-CD Isomer
30-40%



1,5-CD Isomer
10-12%



1,6-CD Isomer
45-50%



C12 LD

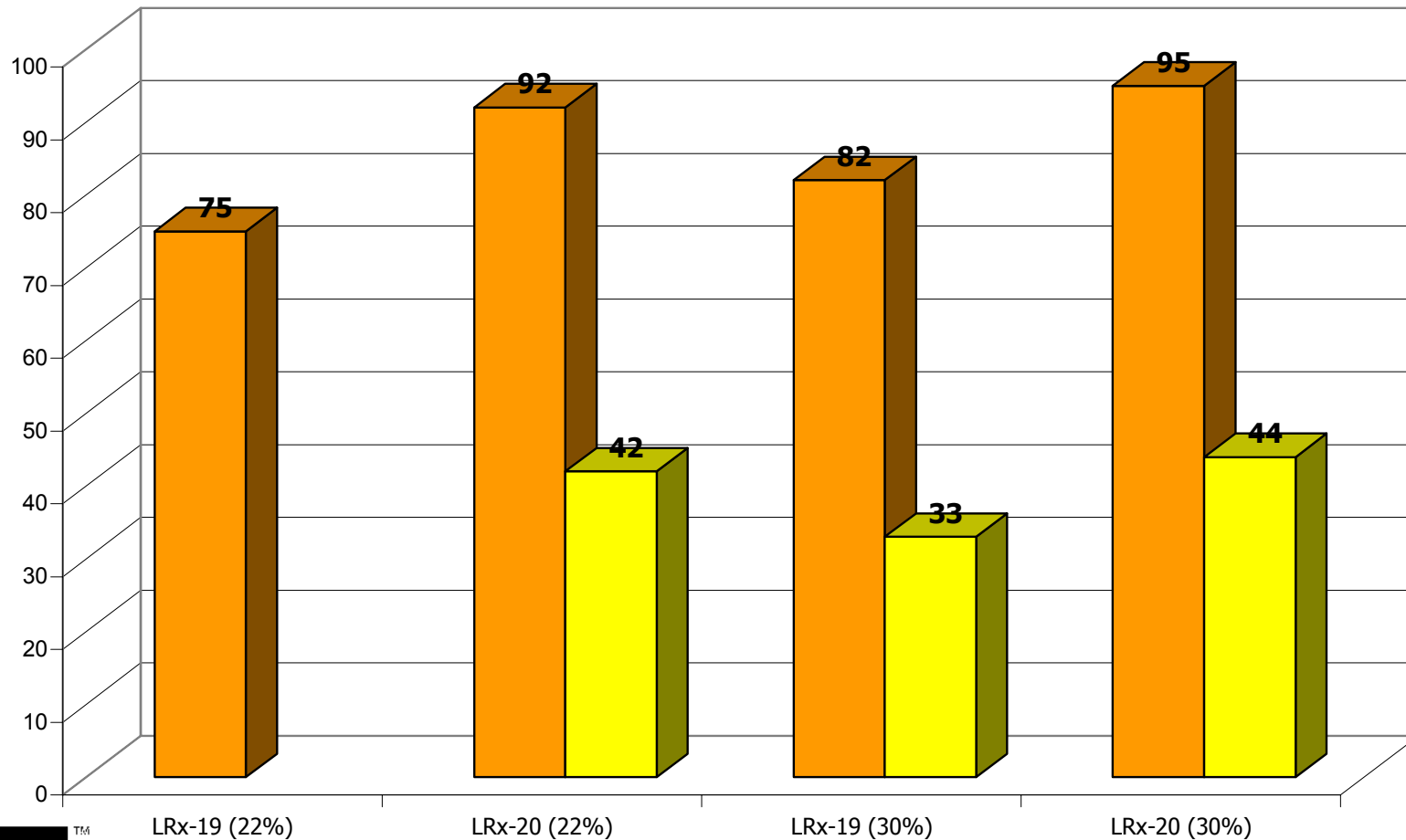


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Polyester Polyol Study

Hardness Scale

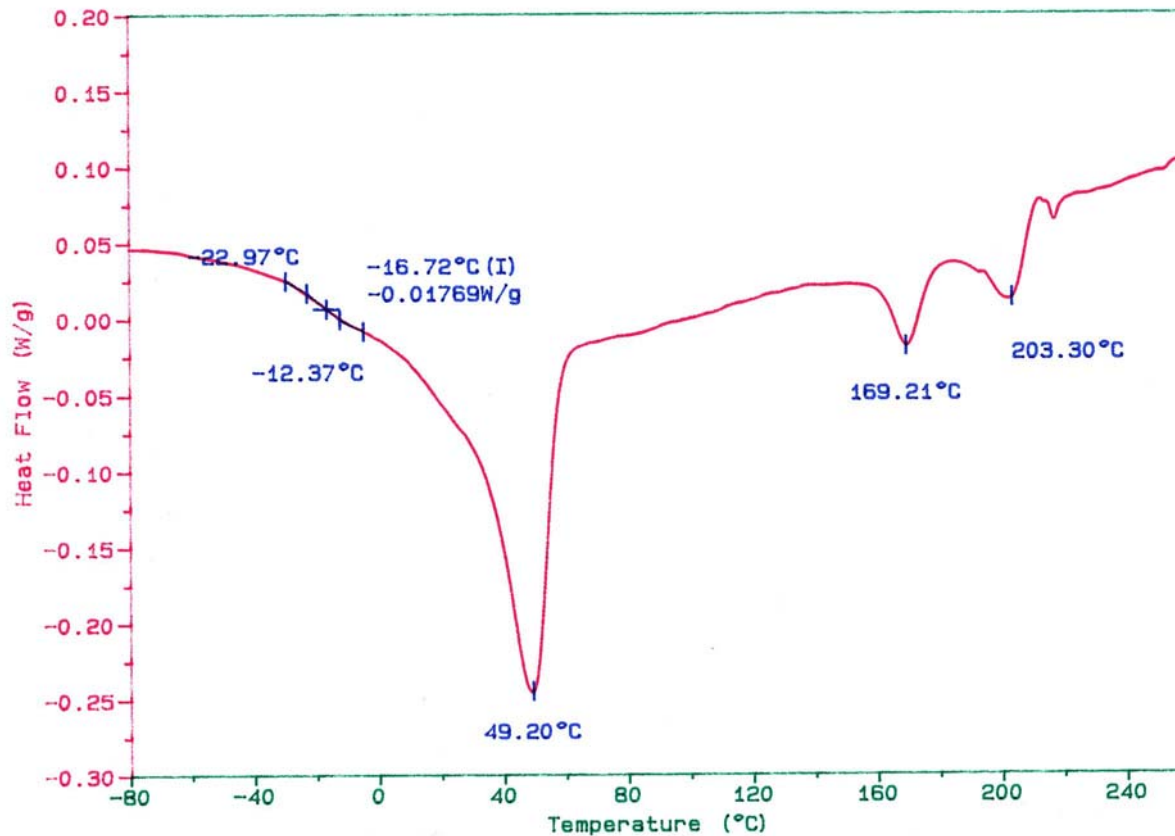


Polyester Polyol Study

Sample: LRX-20
Size: 7.2000 mg
Method: 10°C/min.: -100 to 270°C
Comment: Second Runnig -100 ~ 270°C, under air flow, Troy Polymers Sample

DSC

Operator:
Run Date: 19-Jun-04 10:48



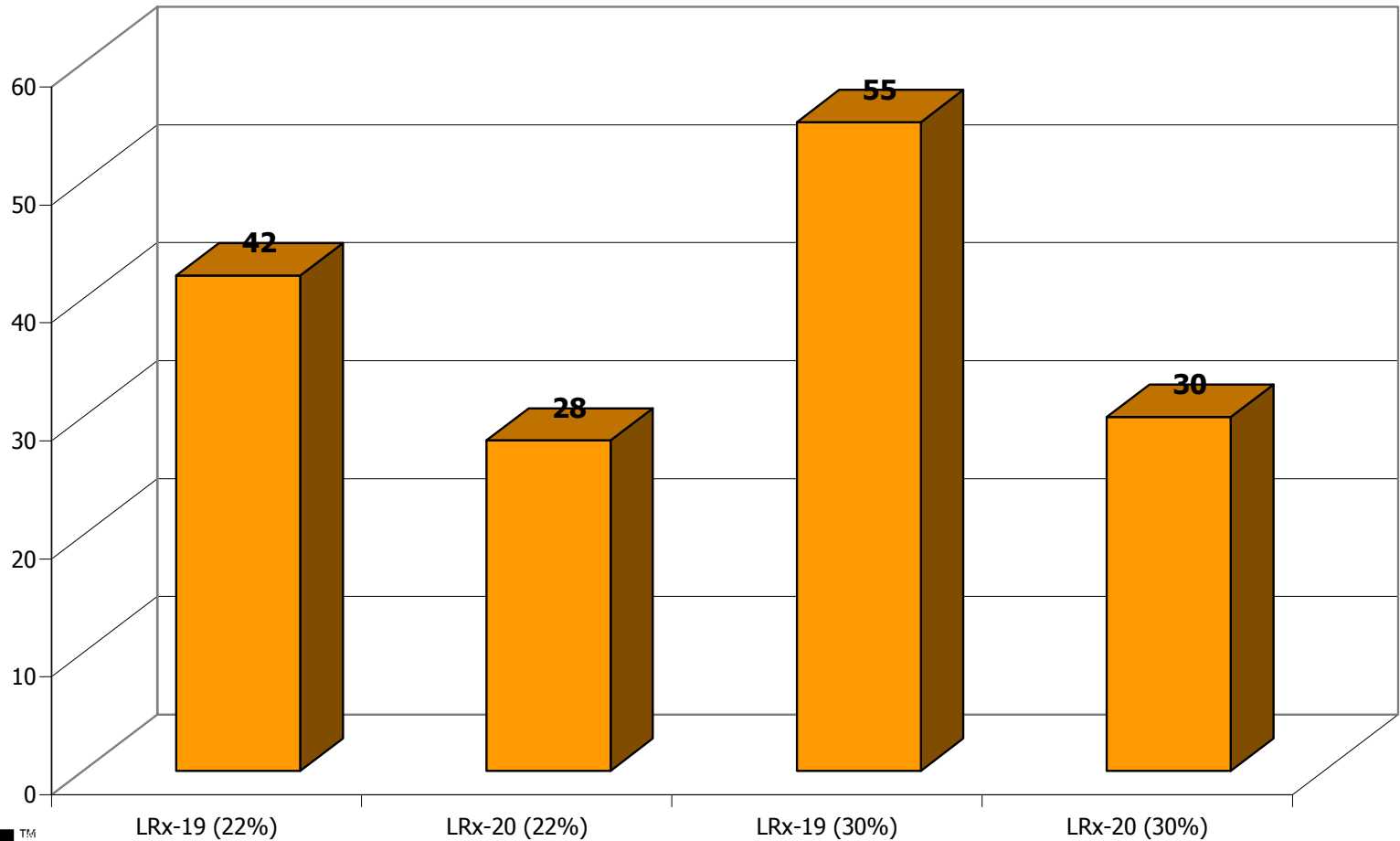
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INVISTA™

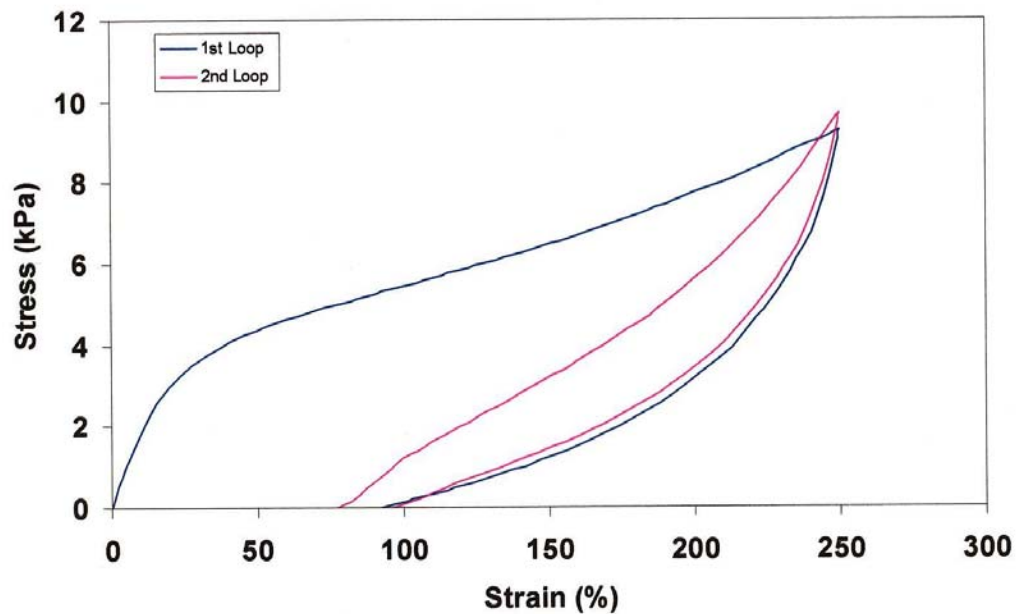
Polyester Polyol Study

Bashore Rebound (%)



Polyester Polyol Study

Hysteresis of polyester elastomers based on LRx-19 polyol

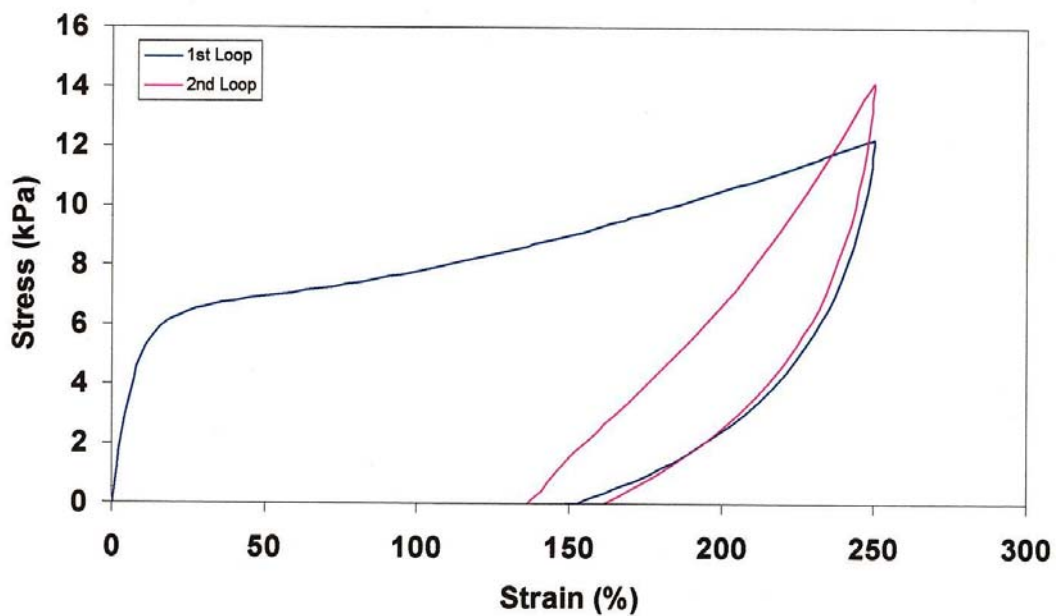


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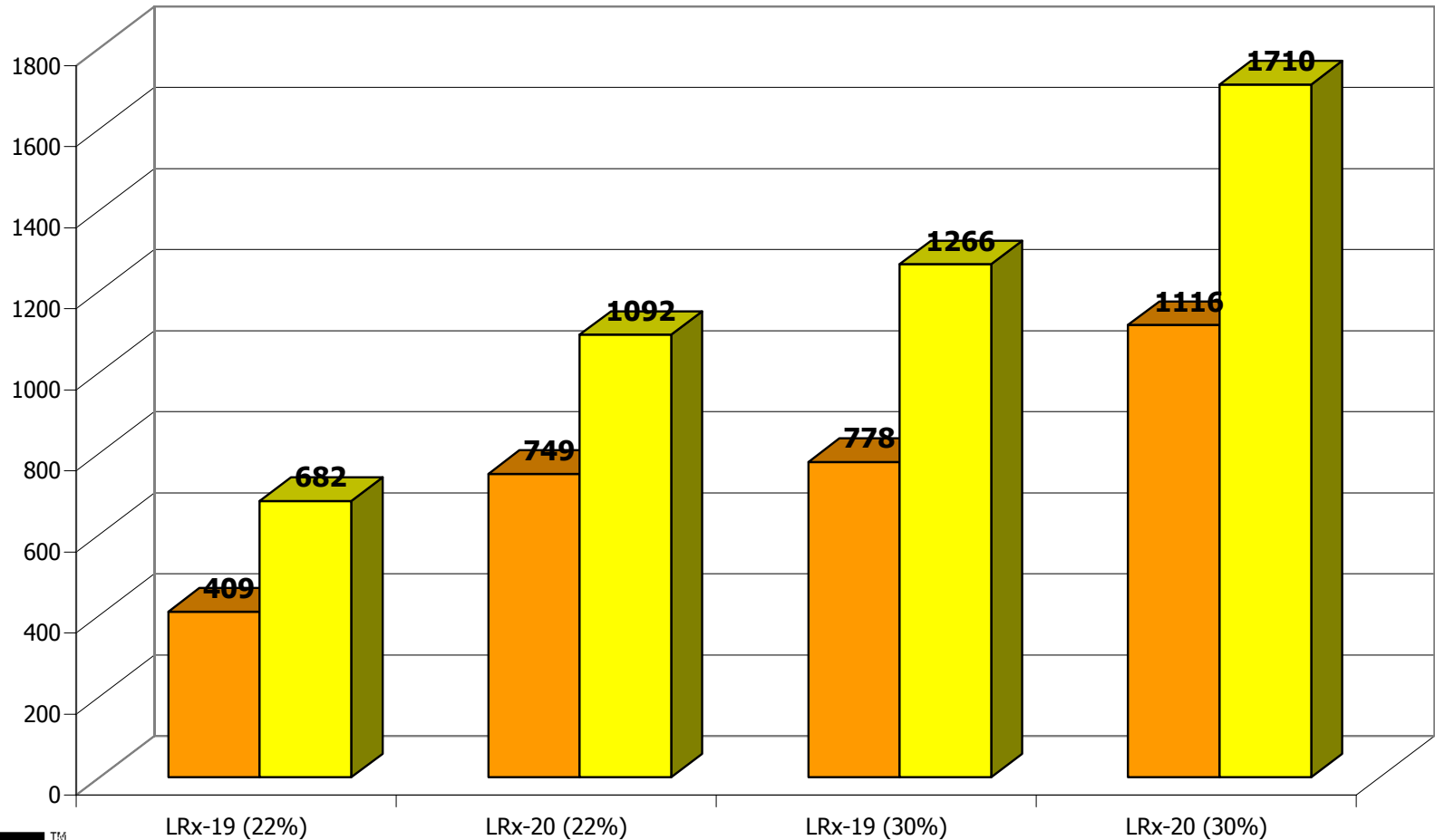
Polyester Polyol Study

Hysteresis of polyurethane elastomer based on LRx-20 polyol



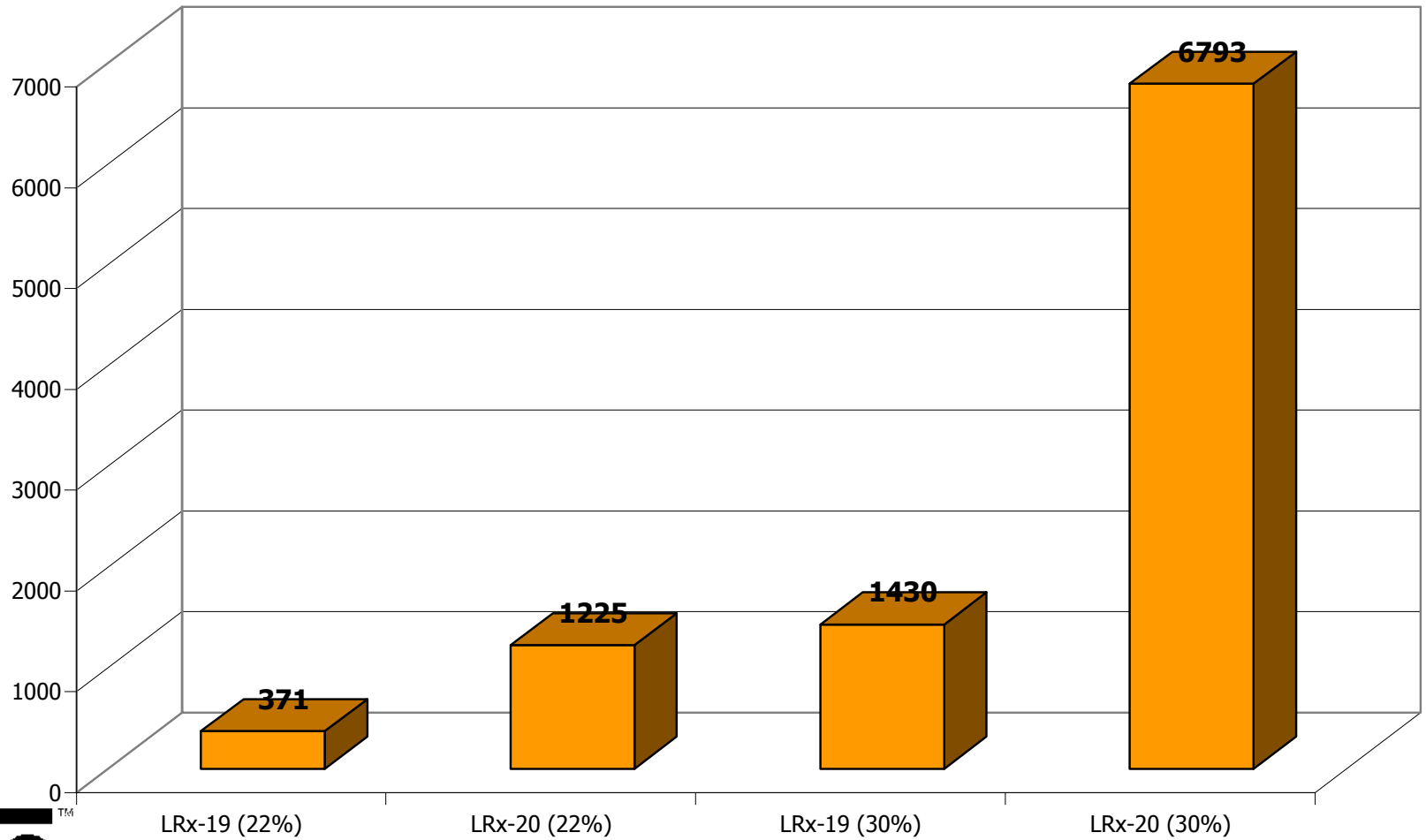
Polyester Polyol Study

Modulus (%)



Polyester Polyol Study

Young's Modulus at 5-10 N



Polyester Polyol Study

Water Immersion Tests*

Initial Properties	LRx-19	LRx-20
Tensile strength, psi	4377	4345
Young's modulus, psi	338	463
Stress at 100% strain, psi	422	570
Stress at 300% strain, psi	664	775

Properties after immersion	LRx-19	LRx-20
Weight increase, %	2.2	1.1
Tensile strength, psi	1499	3264
Retention, %	34	75
Young's modulus, psi	139	413
Retention, %	41	89
Stress at 100% strain, psi	347	558
Retention, %	82	98
Stress at 300% strain, psi	478	759
Retention, %	72	102

*immersion in water for one week at 85 deg C

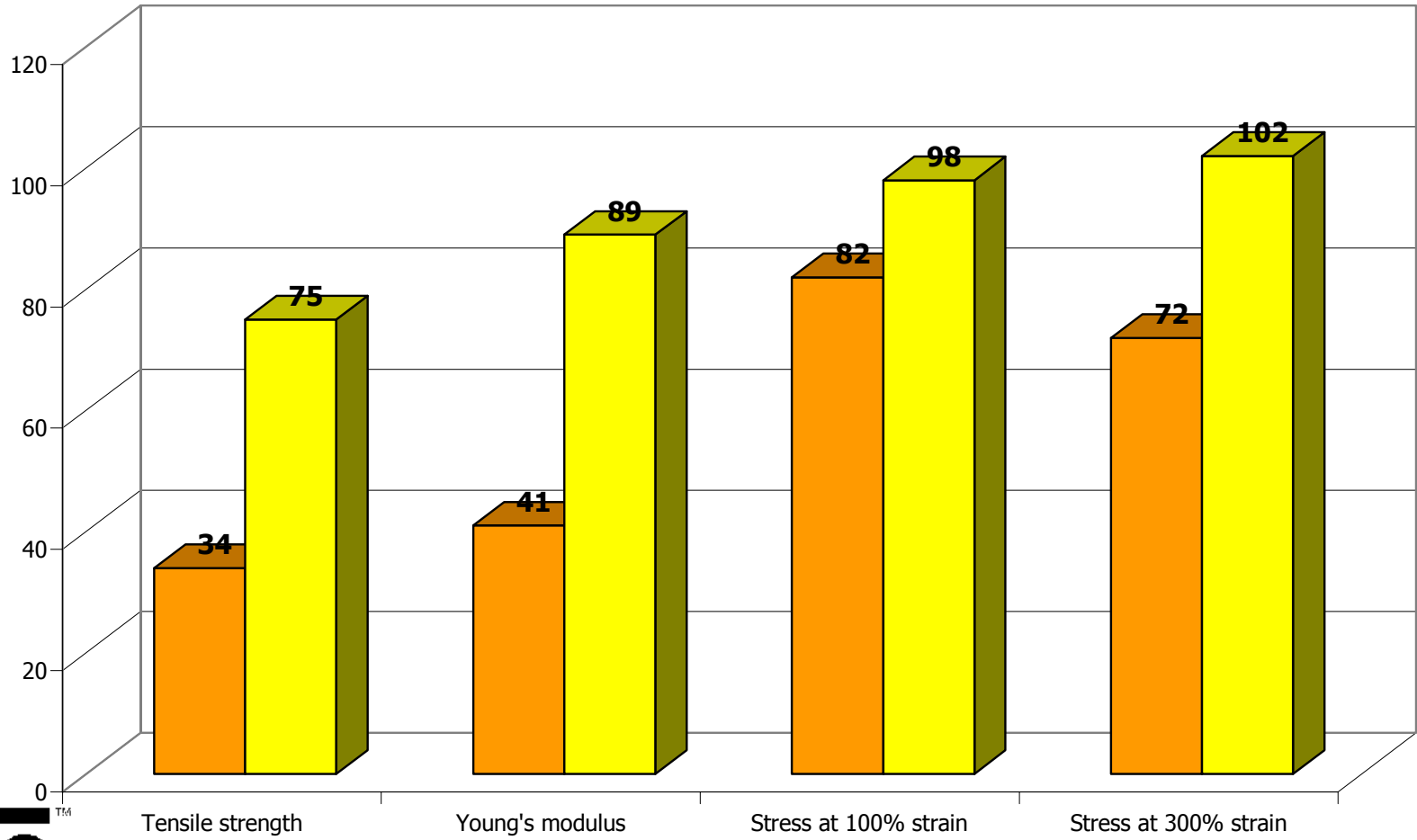


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Polyester Polyol Study

% Retention - Polyester Polyol - Hydrolytic Stability



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1,4-BD C12 LD

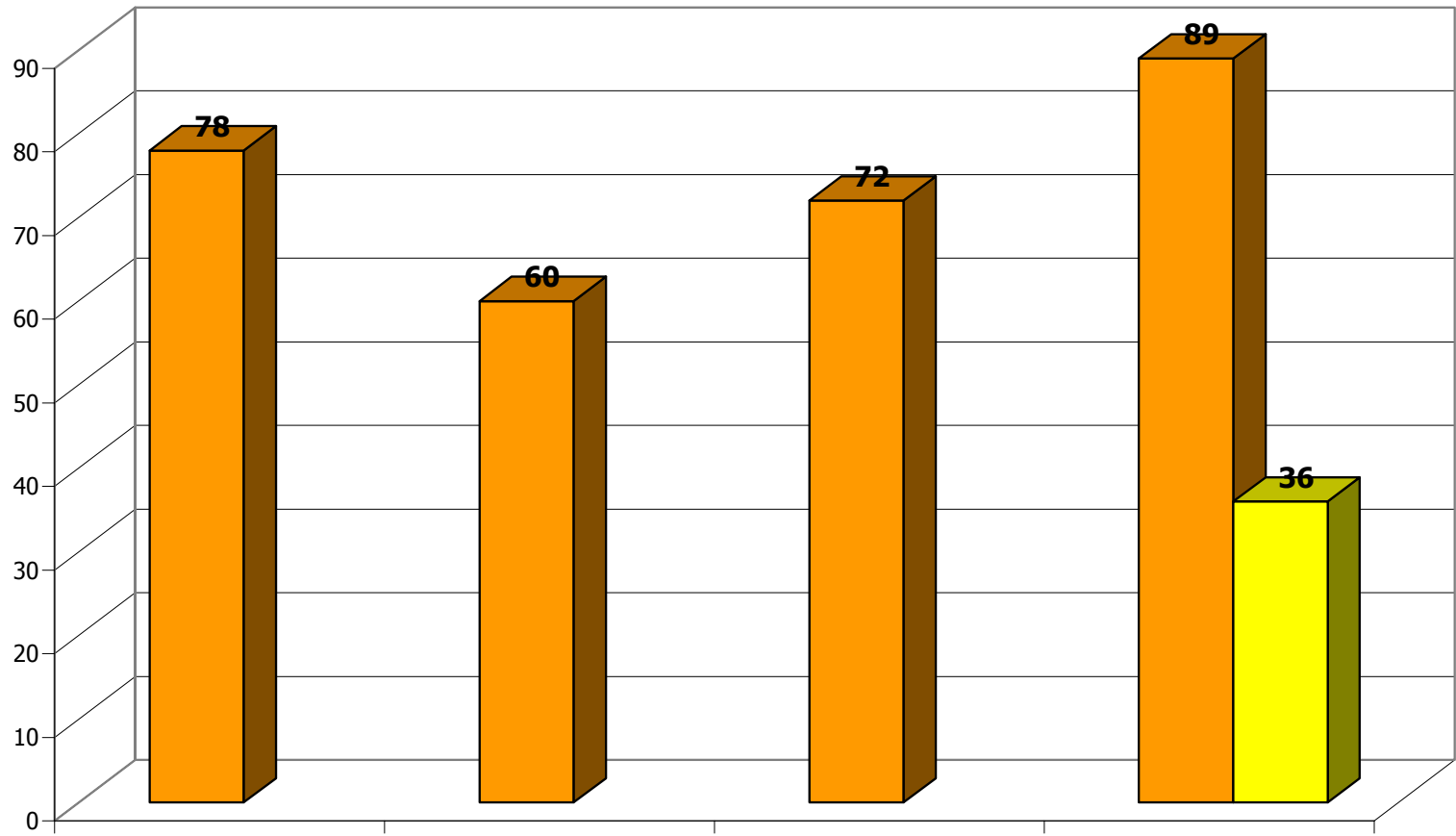


Conclusions – Polyester Polyols

- TPU's based on C12 LD/1,4-BD adipate polyols demonstrate good physical-mechanical properties
 - Increased hardness
 - Higher modulus
- Improved water resistance of elastomers with the C12 LD
- Elastomers exhibited crystalline transitions at 50 °C
 - Important feature for hot melt adhesive applications

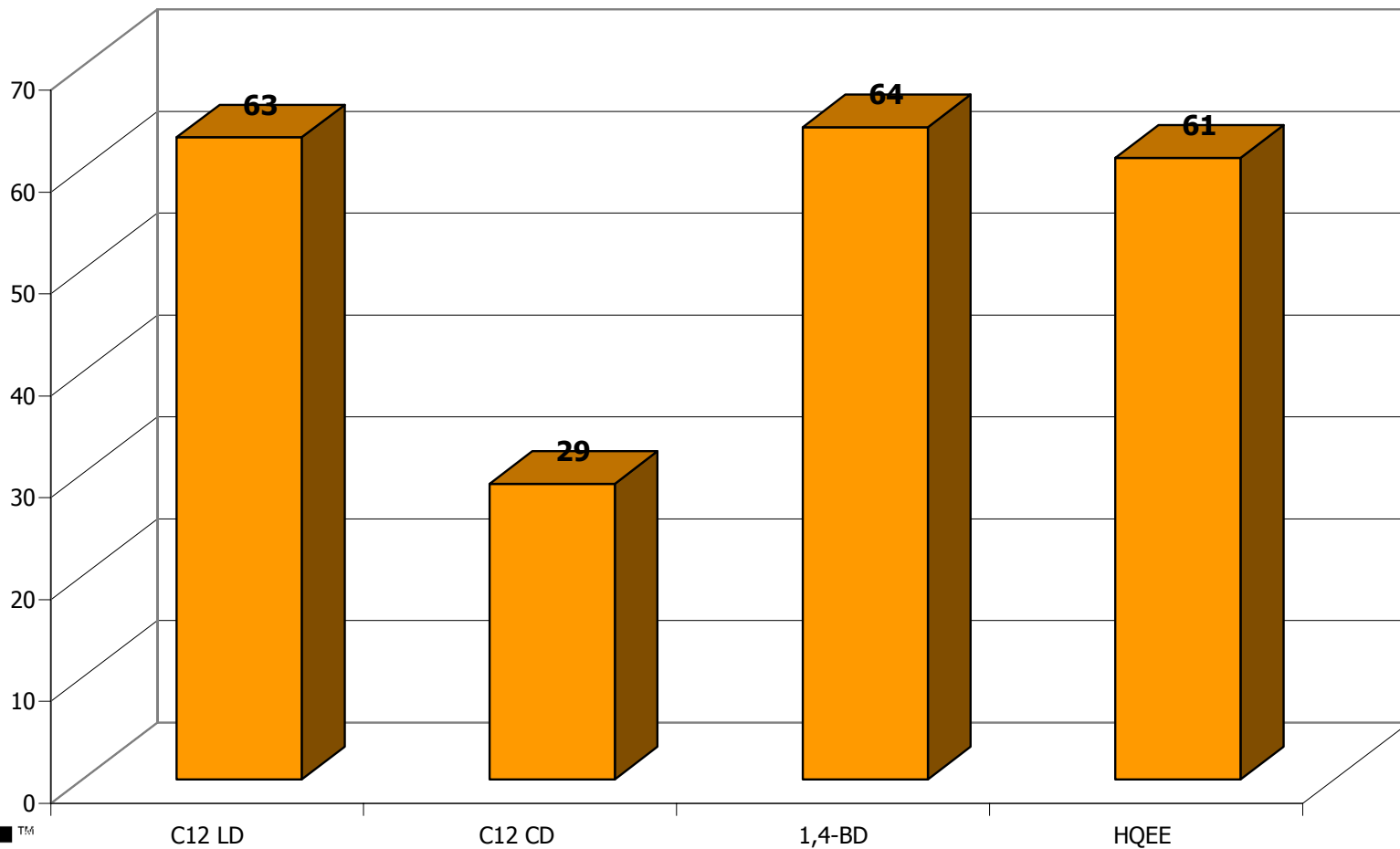
Chainextender Study

Shore Hardness



Chainextender Study

Bashore Rebound (%)

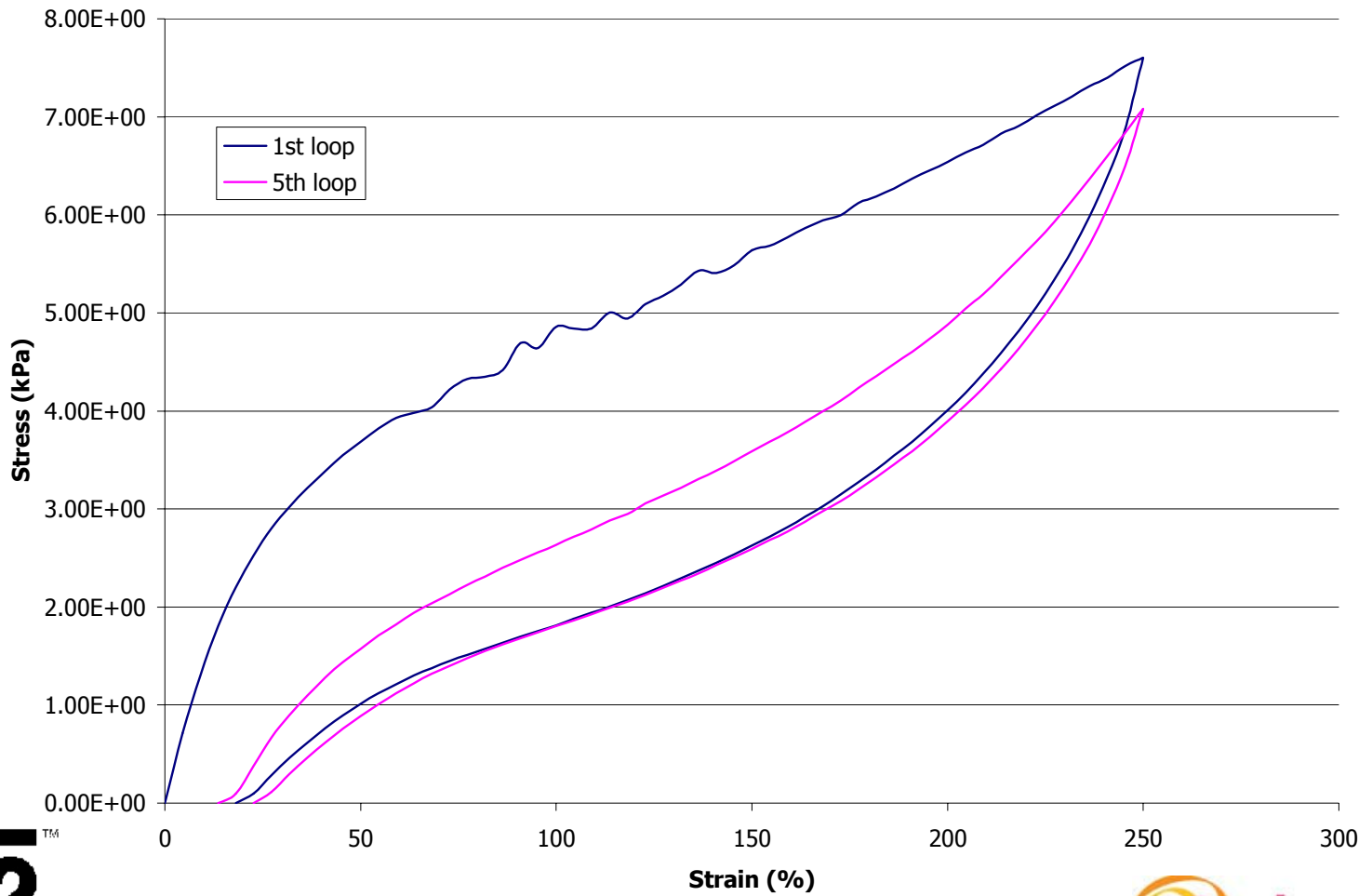


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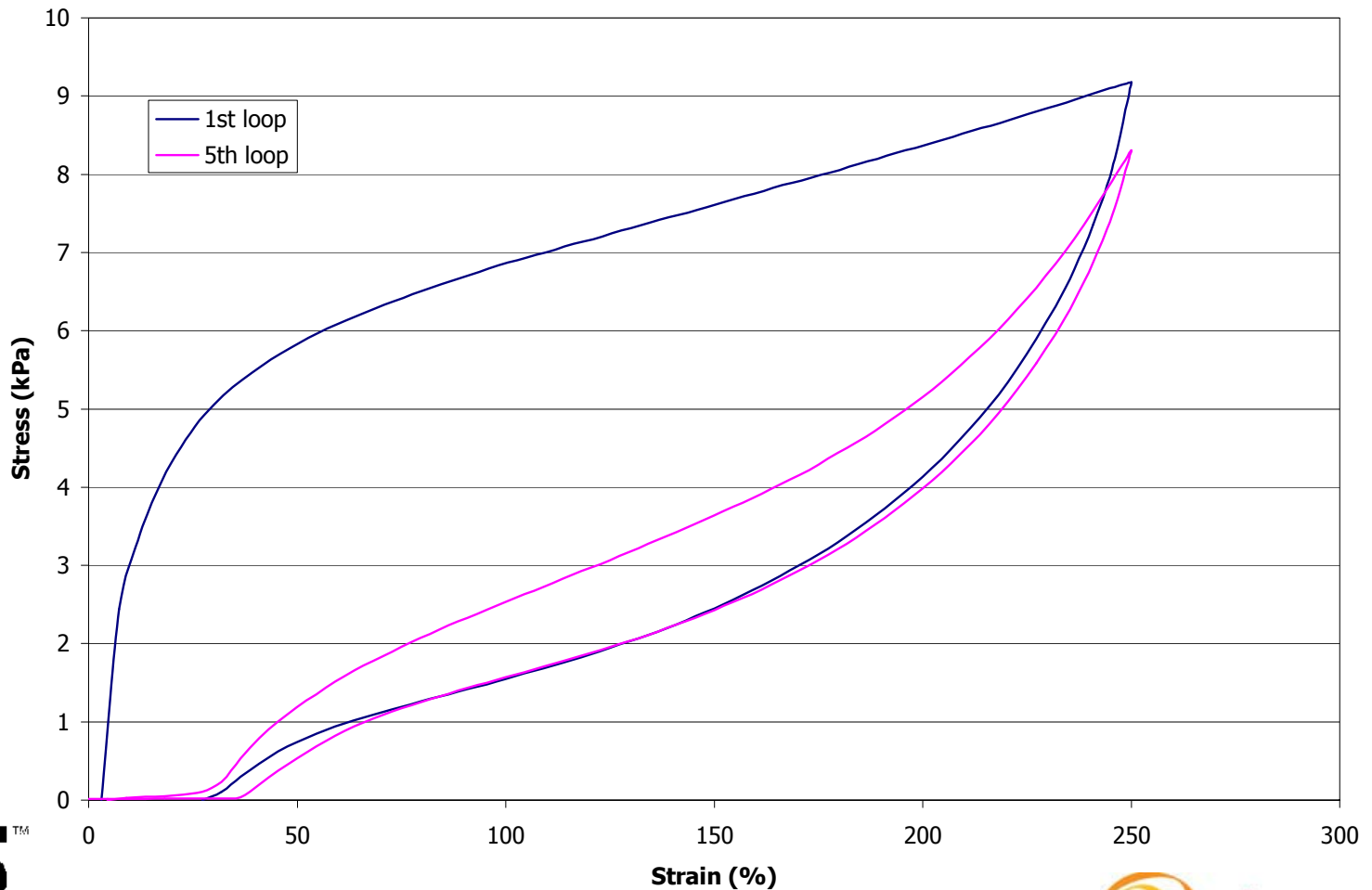
Chainextender Study

Hysteresis of TPU based on 1,4-BD Chain Extender



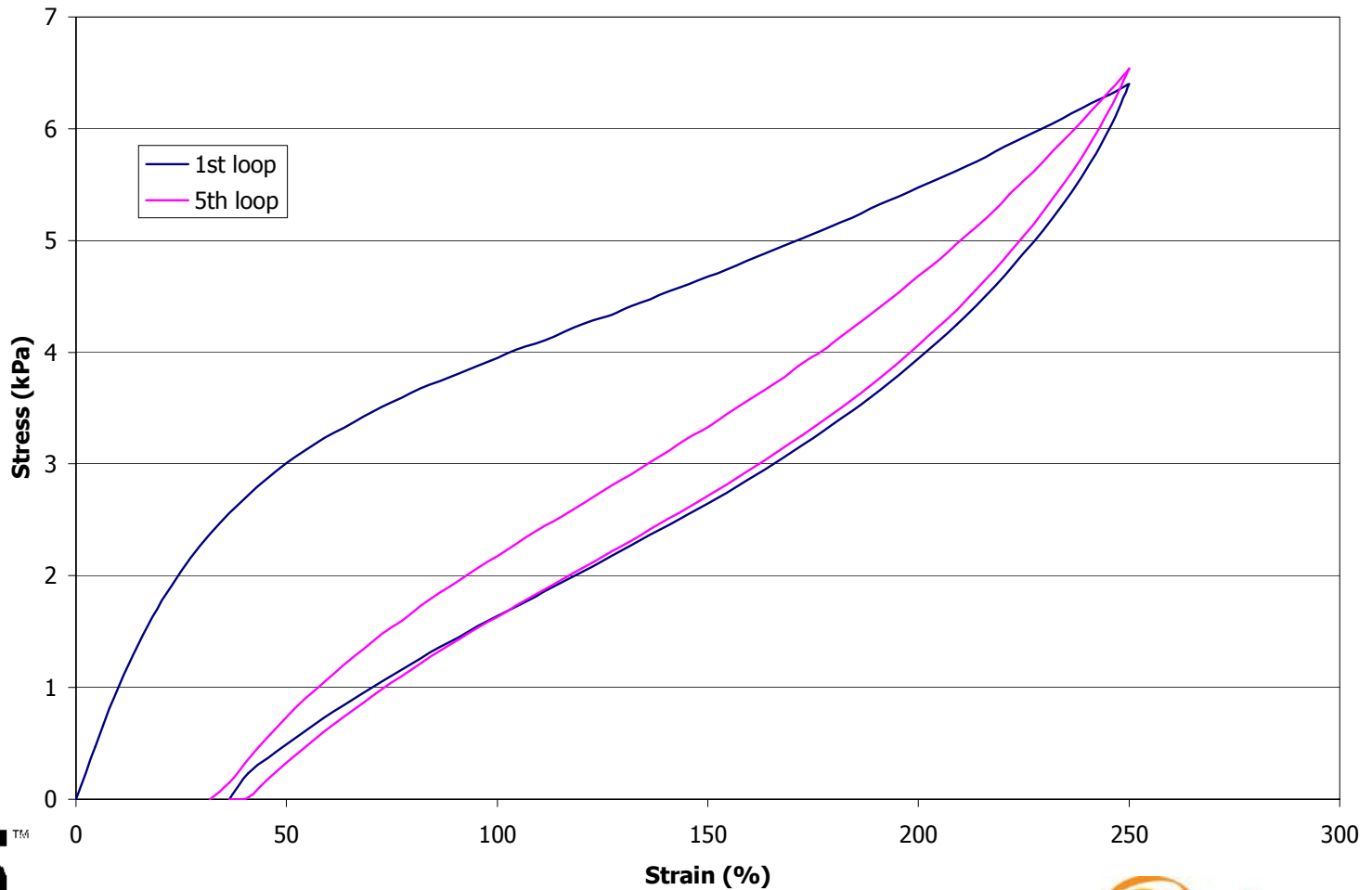
Chainextender Study

Hysteresis of TPU's based on HQEE Chain Extender



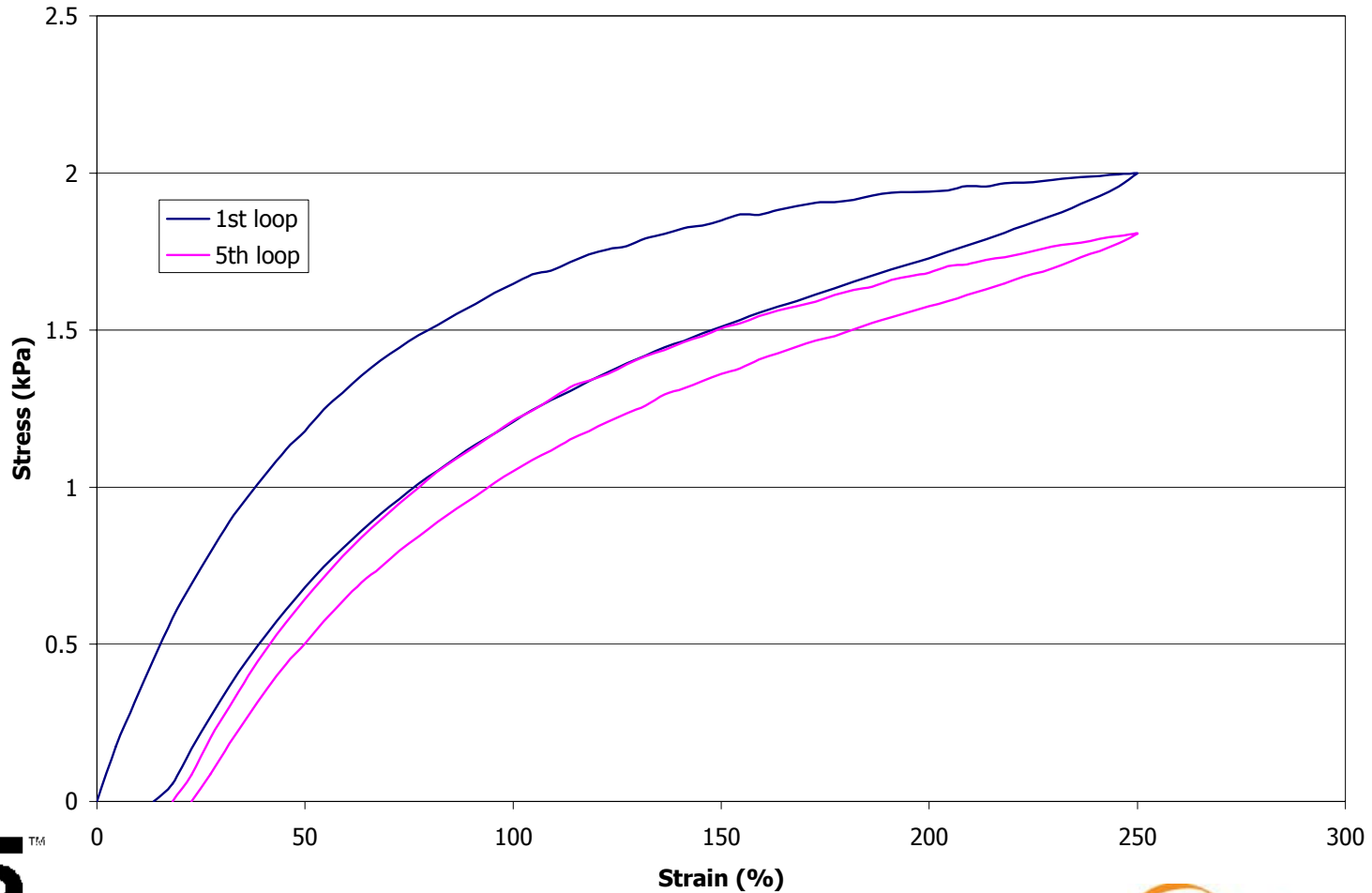
Chainextender Study

Hysteresis of TPU based on C12 LD Chain Extender



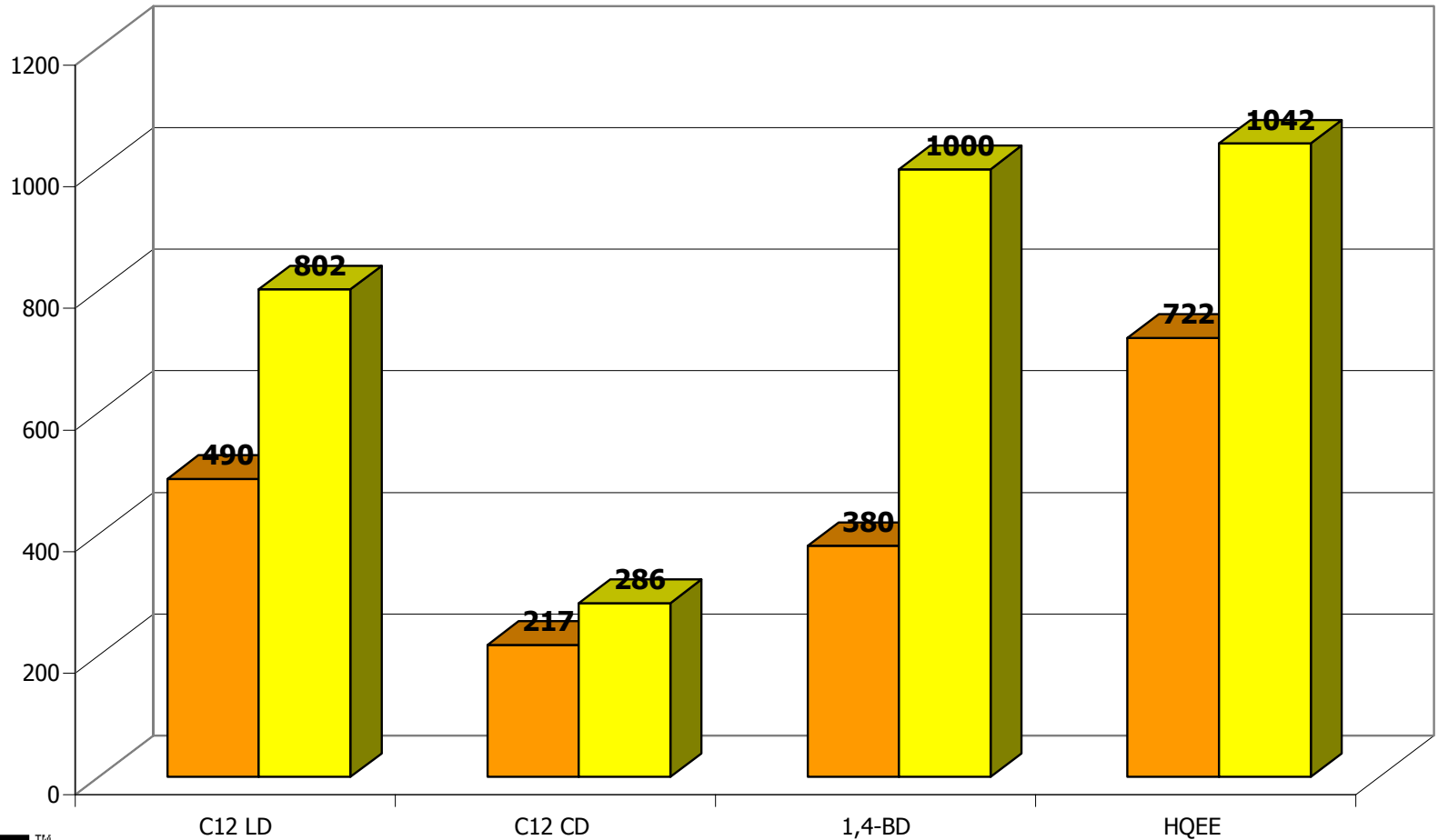
Chainextender Study

Hysteresis of TPU based on C12 CD Chain Extender



Chainextender Study

Modulus (%)



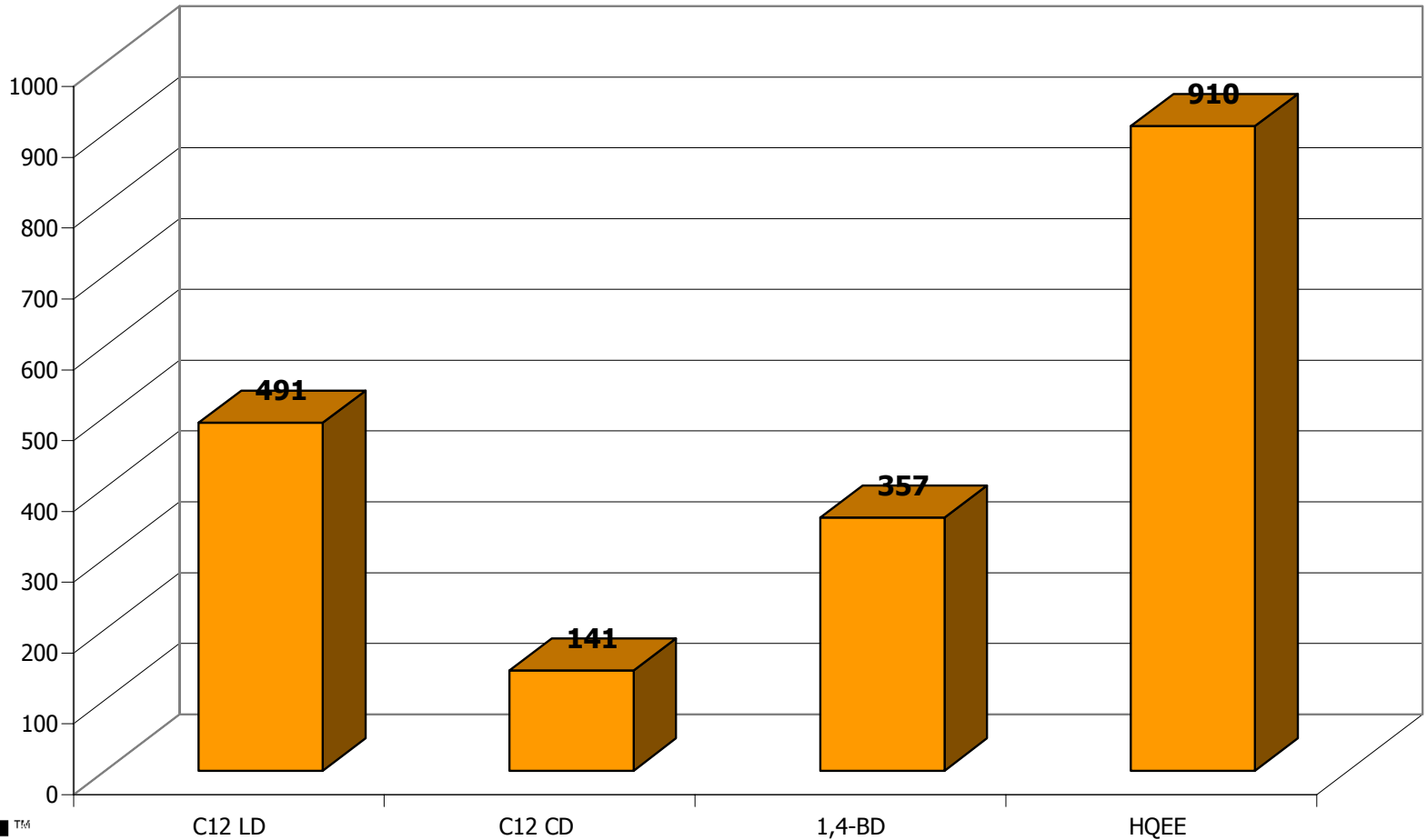
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100% Modulus 300% Modulus



Chainextender Study

Young's Modulus at 5-10 N



Chainextender Study

Water Immersion Tests*

Initial Properties	1,4-BD	C12 LD
Tensile strength, psi	4595	4340
Young's modulus, psi	1142	627
Stress at 100% strain, psi	677	509
Stress at 300% strain, psi	1245	902
Manual Elongation	450	530
Properties after immersion	1,4-BD	C12 LD
Weight increase, %	1.9	1.8
Tensile strength, psi	3035	2934
Retention, %	66	67
Young's modulus, psi	426	406
Retention, %	37	65
Stress at 100% strain, psi	460	444
Retention, %	68	87
Stress at 300% strain, psi	784	778
Retention, %	63	86
Elongation at break	720	750
Increase, %	60	41

*immersion in water for one week at 85 deg C

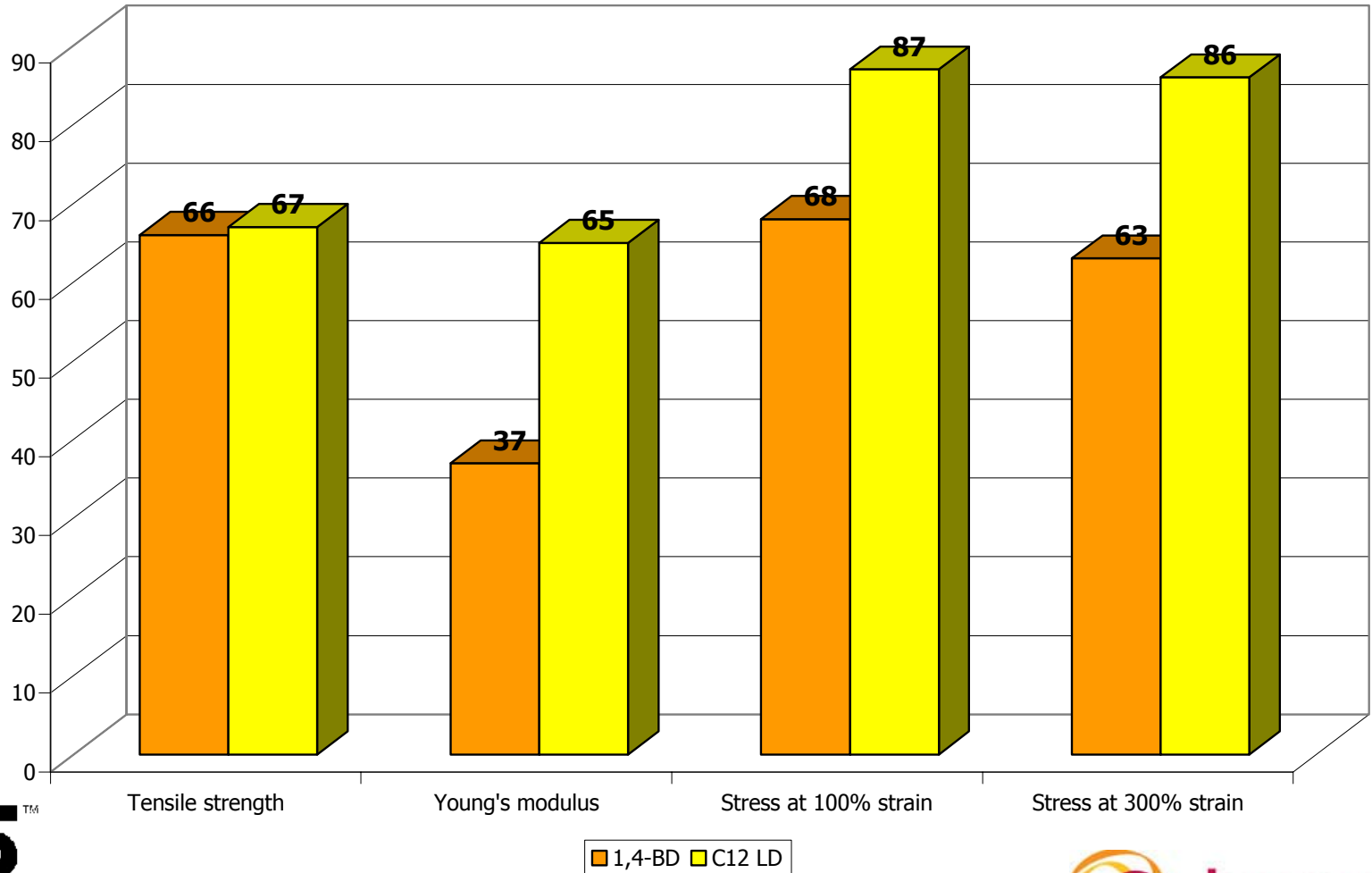


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Chainextender Study

% Retention - Chainextenders - Hydrolytic Stability



Conclusions – Chainextenders

- Excellent combination of properties using C12 LD as chain extender compared to 1,4-BD chain extender.
 - Good physical-mechanical & thermal properties
 - Excellent resilience & improved moisture resistance
- C12 CD elastomers were soft, Shore A 60, and had lower compressive strengths & hardness, but had a high softening temperature.
- C12 CD showed very low hysteresis & excellent compression set.
 - Soft PU elastomers can be used in printing wheels, sealants, medical applications, synthetic leathers, fibers, etc.



High Performance Intermediates

