A Novel Additive for Nylon Enabling High Flow,Metal Release and Enhanced Physical Properties

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STP0277

Struktol Company of America

- Member of the Schill & Seilacher family of companies
- Manufacturing in:
  - Stow, OH
  - Hamburg, Germany
  - Böblingen, Germany
  - Pirna, Germany
- Representation in over 100 countries around the world
- STRUKTOL® trade name known around the world
- Products can be found in plastics and rubber as well as man-made fibers, textiles, leather and paper products

Struktol Company of America

- Process and functional additives for compounds and resins based on:
  - Thermoplastics including:
    - Polyolefins
    - Styrenics
    - PVC
    - ***Engineered Plastics***
  - Thermoset elastomers

STRUKTOL® TR 063A

- Novel molecule designed specifically for polyamide processing
  - Nylon 6
  - Nylon 66
- Unique chemistry highly compatible with amide polymers
- Unmatched metal release characteristics
- Superior flow improvement
- Minimal impact on physical properties
- Replaces common lubricants/release agents such as:
  - EBS, metal stearates, montan esters
- Can be added during compounding or at molding machine

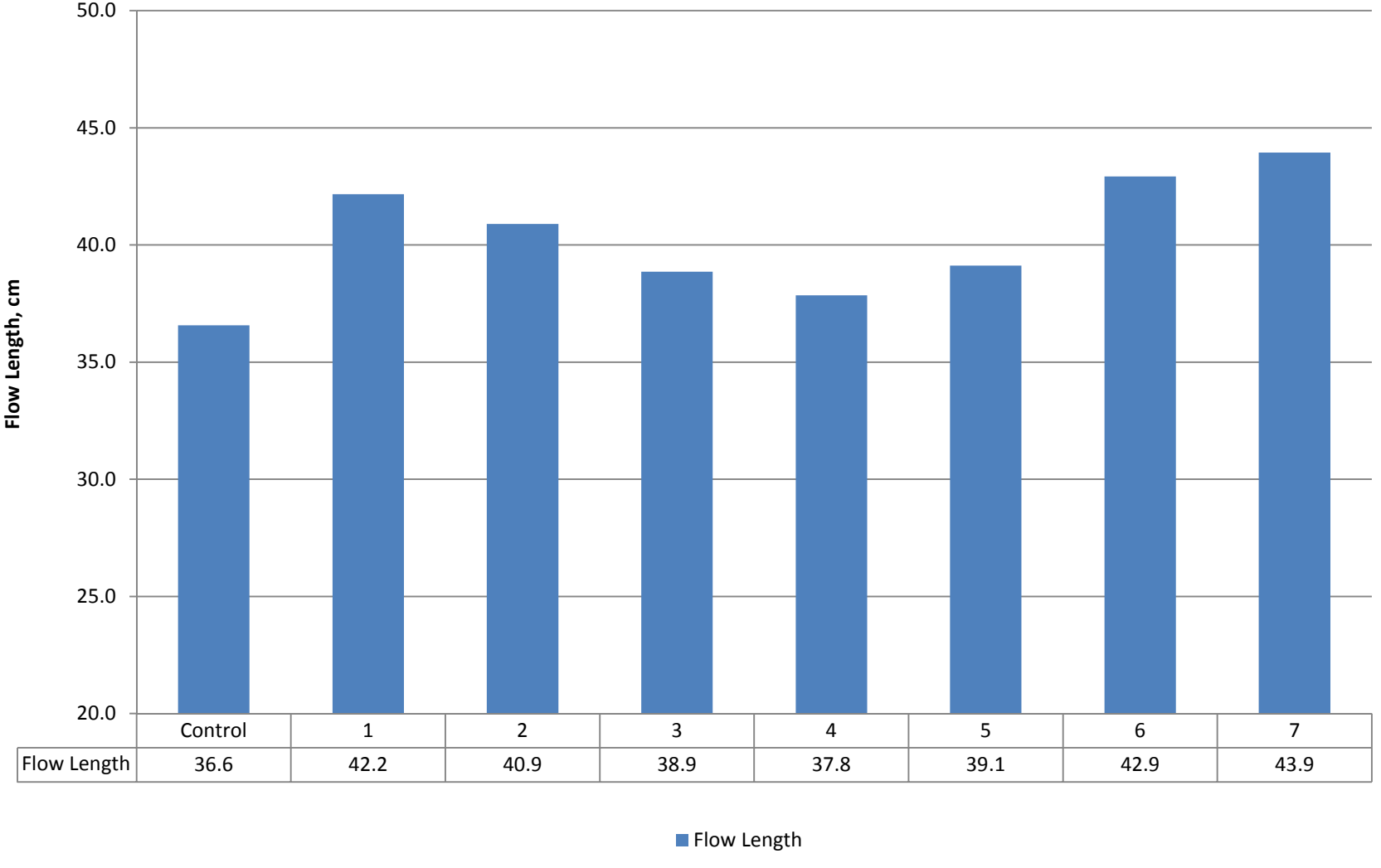
STRUKTOL® TR 063A

Properties in Unreinforced Nylon 6

Formulations:

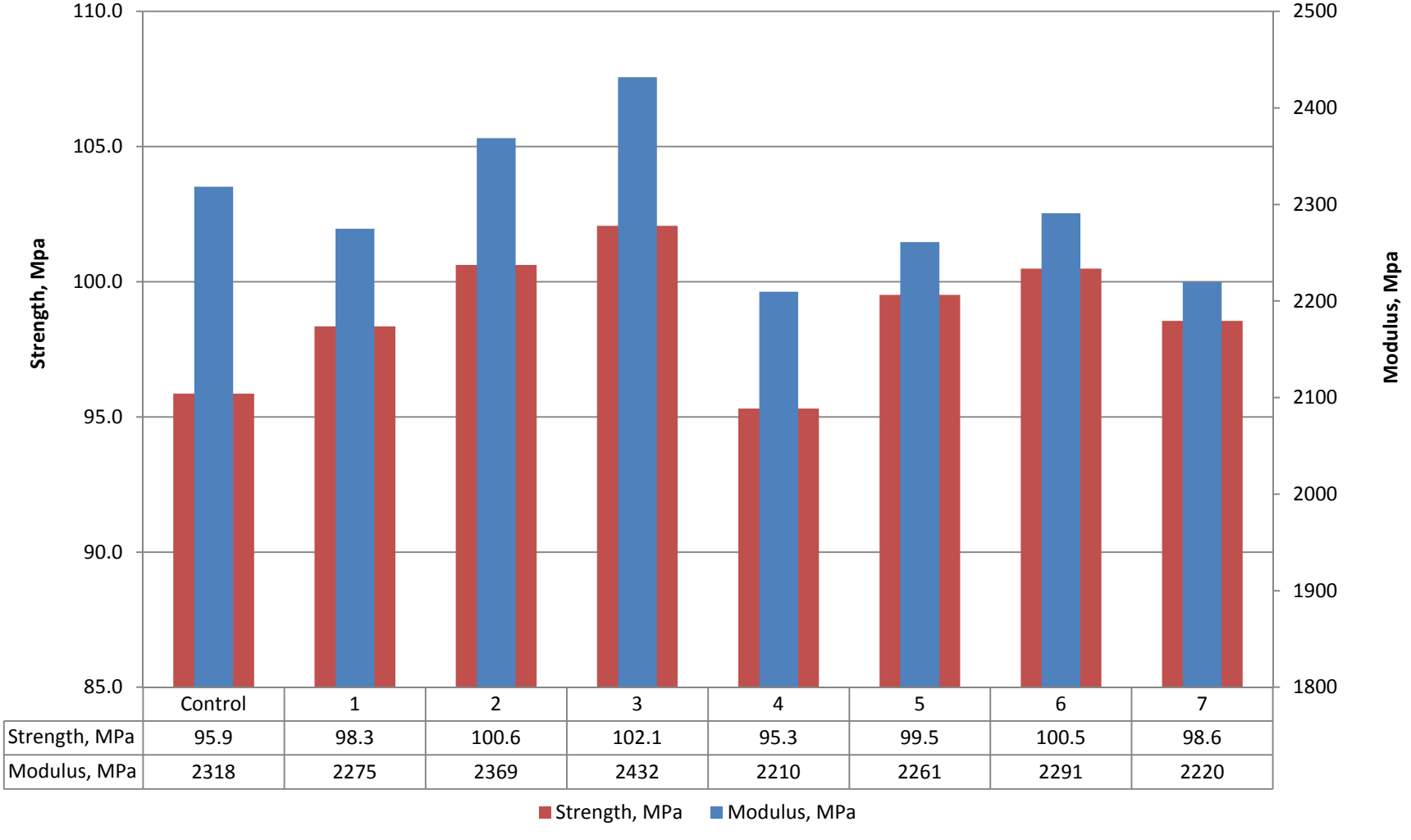
	Control	1	2	3	4	5	6	7
Ultramid B27E01	100	99	99	99	99	99.5	99	98
Zinc Stearate		1						
EBS			1					
Struktol TR 044W				1				
Montan Wax E					1			
Struktol TR 063A						0.5	1	2

Spiral Mold Flow Comparison:



	Control	1	2	3	4	5	6	7
Flow Length	36.6	42.2	40.9	38.9	37.8	39.1	42.9	43.9

Flexural Properties:



	Control	1	2	3	4	5	6	7
Strength, MPa	95.9	98.3	100.6	102.1	95.3	99.5	100.5	98.6
Modulus, MPa	2318	2275	2369	2432	2210	2261	2291	2220

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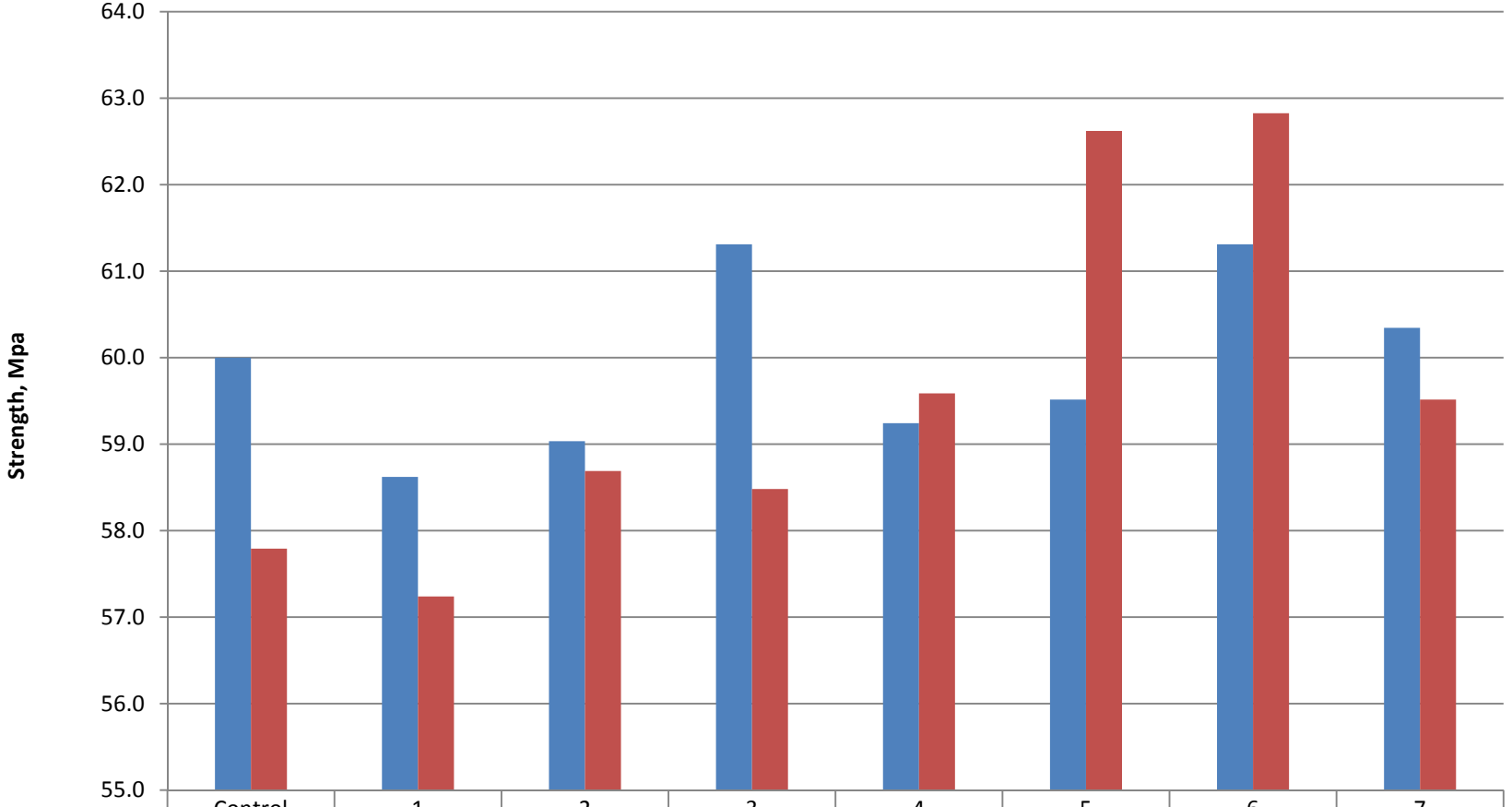
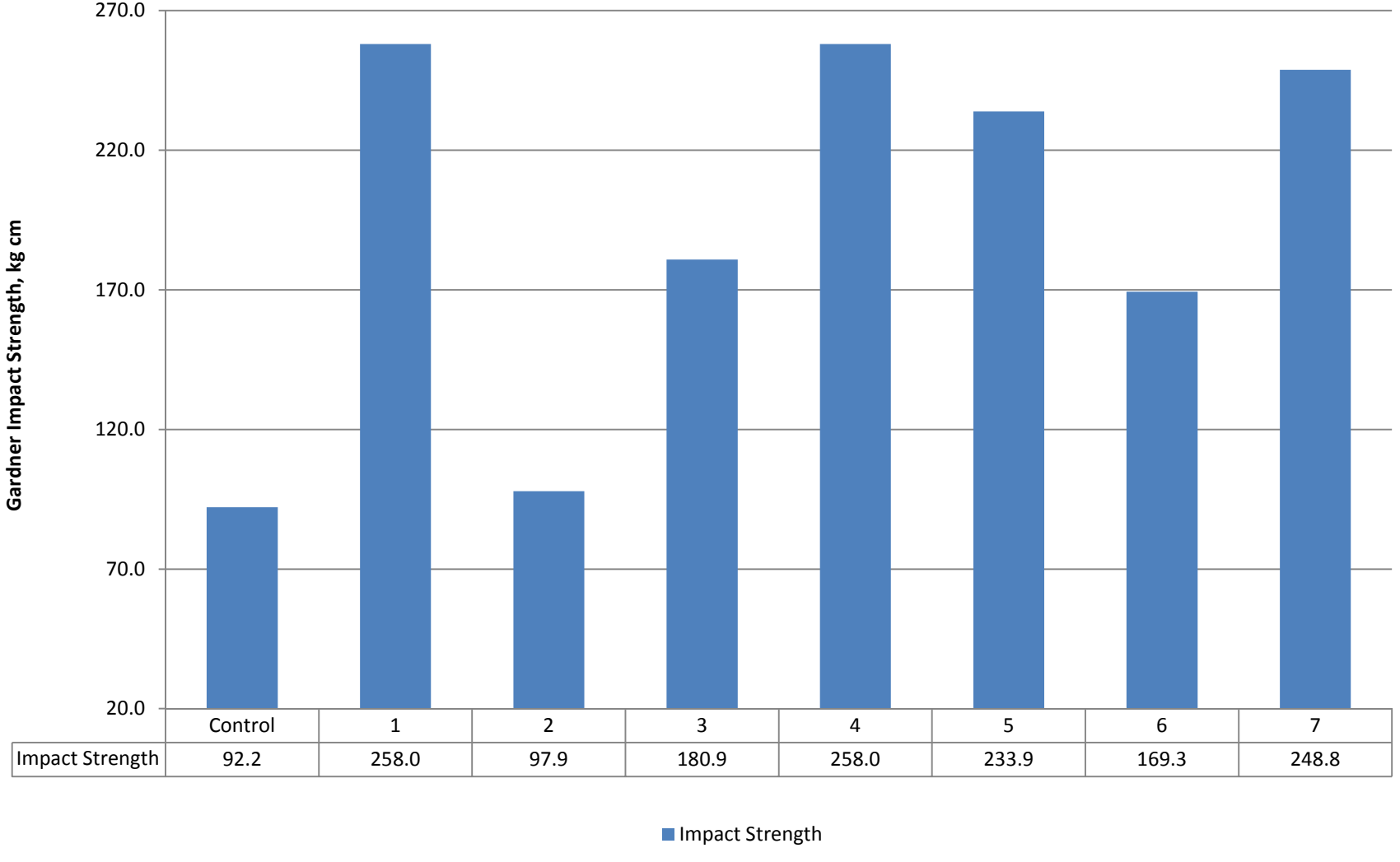
Tensile Properties:



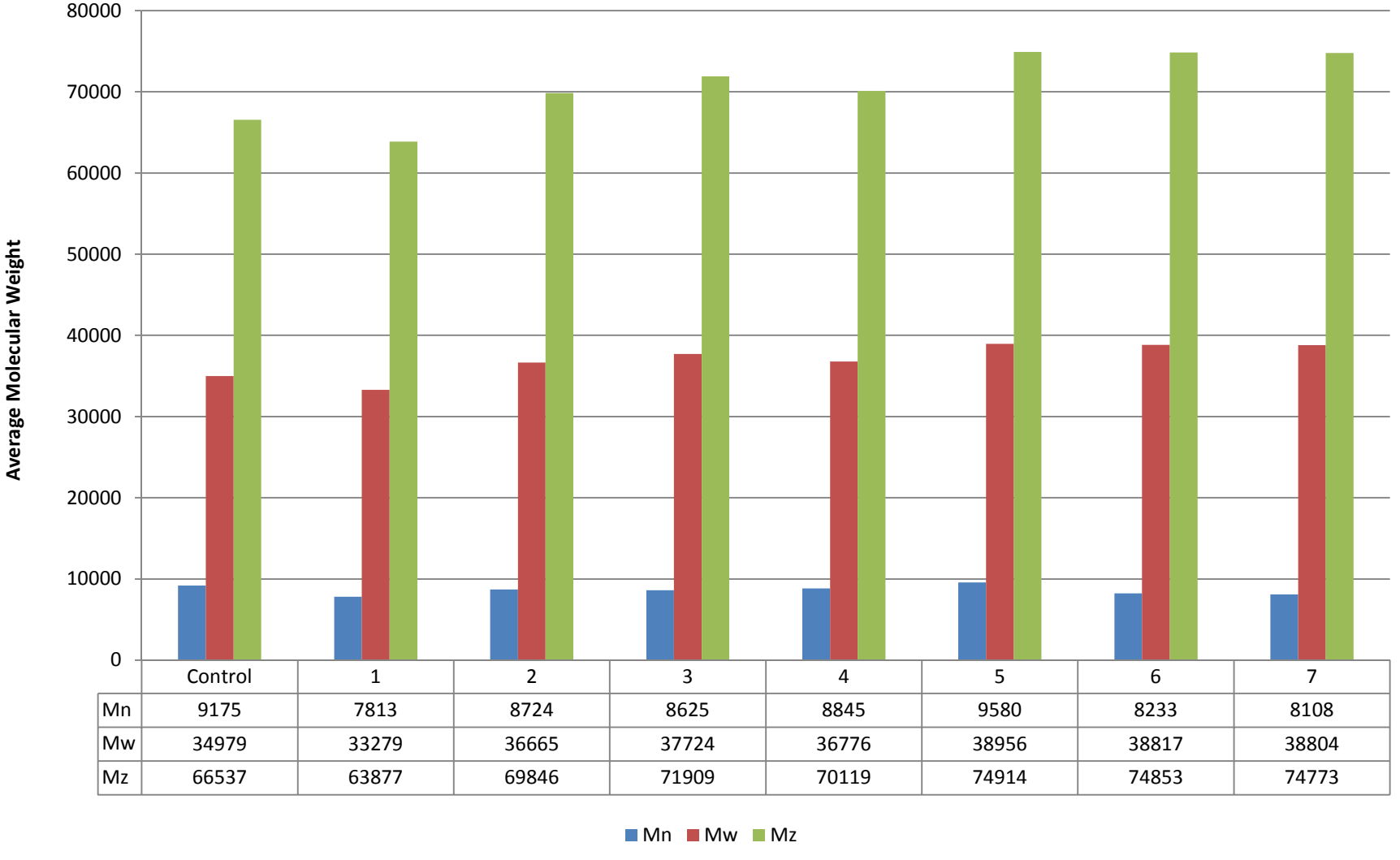
	Control	1	2	3	4	5	6	7
Strength, MPa	60.0	58.6	59.0	61.3	59.2	59.5	61.3	60.3
Knit Line Strength, MPa	57.8	57.2	58.7	58.5	59.6	62.6	62.8	59.5

Gardner Impact Strength:



	Control	1	2	3	4	5	6	7
Impact Strength	92.2	258.0	97.9	180.9	258.0	233.9	169.3	248.8

Molecular Weight Analysis:



	Control	1	2	3	4	5	6	7
Mn	9175	7813	8724	8625	8845	9580	8233	8108
Mw	34979	33279	36665	37724	36776	38956	38817	38804
Mz	66537	63877	69846	71909	70119	74914	74853	74773

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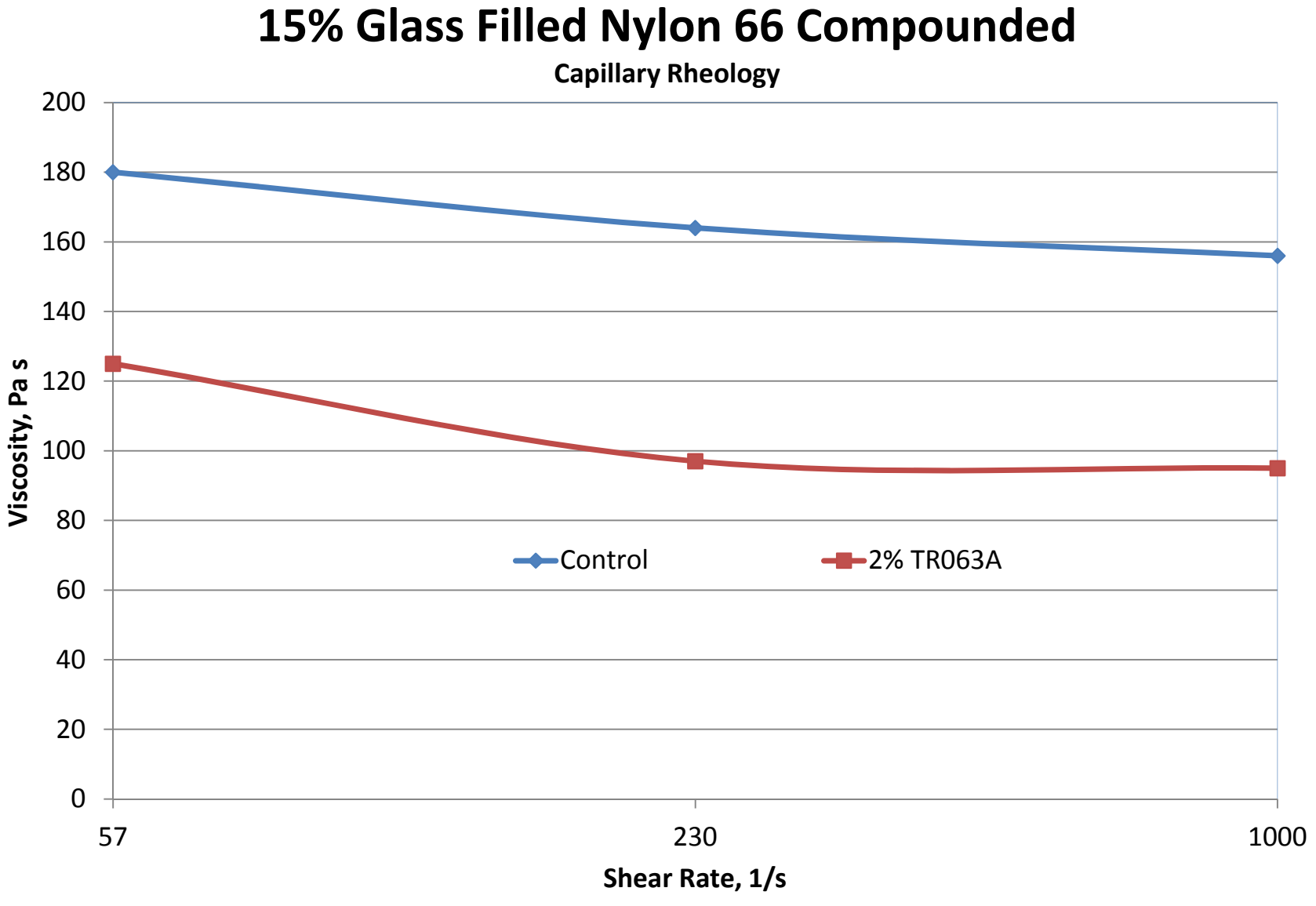
STRUKTOL® TR 063A

Properties in Glass Reinforced Nylon 6 and Nylon 66

Viscosity Reduction



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Compounding/Processing Improvements

15% glass filled nylon 66 process in a twin screw extruder at 280°C and 100 rpm:

	0.5% TR 063A	1.0% TR 063A	2.0% TR 063A
Torque Reduction	-15%	-24%	-31%

Pre-compounded 33% glass fiber nylon 66:

	Control	0.5% TR 063A	1.0% TR 063A	2.0% TR 063A
Torque Reduction	--	-10%	-20%	-30%
Spiral Flow, inches	17.0	17.3	17.9	20.2
MFR (275°C, 0.325 kg)	4.2	4.7	6.2	9.1
MFR (275°C, 2.16 kg)	49.8	52.2	60.6	**

Additive blended at molding machine in 33% glass fiber nylon 66:

	Control	2% Montan Wax E	1.0% TR 063A	2.0% TR 063A
Spiral Flow, inches	18.5	19.3	19.5	23.6

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Compounding/Processing Improvements

DSM Akulon K224 HG6 30% glass nylon 6 pre-compounded:

	Control	1% TR063A	1% TR077
MFR, 275°C/2.16 kg	25.9	53.0	31.8
Spiral Flow, inches	18.9	23.1	19.8

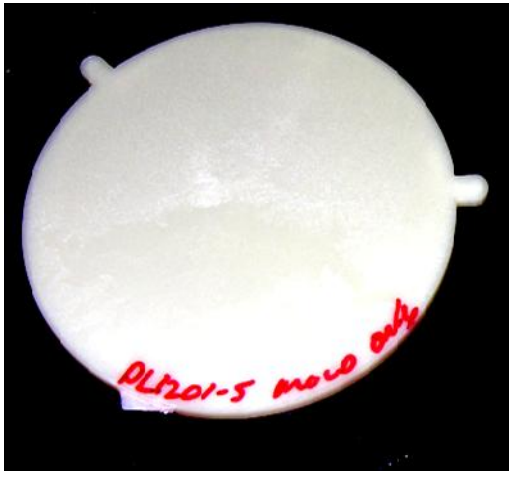
Die Build-up

STRUKTOL® TR 063A has been shown to significantly extend process times before seeing significant die build-up during compounding. Field trials show that glass fiber filled compounds containing as low as 0.5% TR 063A can run hours longer than compounds without the additive before having to clean off the dies. This equals manufacturing efficiencies and better product quality.

Injection Molding Improvement

33% glass filled nylon 66 injection molded at a nominal 270°C. Good moldings were made of the control material and then the machine was set up to deliberately produce short shots. Without changing the machine settings the control material was dry blended with 1% TR 063A and molded:

Control Short Shot



1% TR 063A Short Shot

Physical Property Effects

15% glass filled nylon 66 twin screw compounded at 280°C and 100 rpm, molded and tested dry-as-molded:

	Control	2.0% TR 063A
Tensile Strength, kpsi	10.6	10.1
Tensile Elongation, %	1.6	2.1
Flexural Modulus, kpsi	540	500
Notched Izod, ft lbs/in	0.8	0.9

CONCLUSIONS:

- Struktol TR 063A has a significant effect on viscosity and flow in both unreinforced and reinforced nylon compounds
- Struktol TR 063A combines flow improvement with improved physical properties vs. traditional lubricant chemistries
- Struktol TR 063A appears to have an effect on molecular weight of processed nylon 6
- Struktol TR 063A significantly reduces die build-up during compounding/processing

Further Work Underway

- Wollastonite filled nylon 6
- Effects on functional additives/coupling agent performance
- Surface characteristics
- Improved regrind dispersion and usage

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