

# Nylon Degradation in Processing, Recycling and Service Life & How To Avoid It.

Dr. A. Zad



A Full Portfolio of Solutions to Plastics Industry



# Nylons in general

- Nylons were amongst the new and exciting materials in 1930s. Their application has undergone a steady and remarkable growth since then.
- Nylon is used in clothing, nonwovens, carpets, hosiery, rope tire cord, brush bristles, industrial conveyor belts, hot air balloons, airbags for cars, zips, gears, wire insulation and piping and etc.



# Advantages

- ✓ High Toughness
- ✓ High Abrasion Resistance
- ✓ High and Low Temperature resistance
- ✓ Low Coefficient of Friction
- ✓ High Tear Resistance
- ✓ Resistant to Oil, Solvents and Alcohols
- ✓ Not affected by Fungi and molds

# Disadvantages



- ✗ Hydrophilic nature (adsorbs moisture in molecular level and swells)
- ✗ Decompose under sunlight
- ✗ Subject to attack by strong acids and oxidizing agents
- ✗ High shrinkage in molded sections
- ✗ Electrical and mechanical properties influenced by moisture content
- ✗ Hard to Recycle and maintain properties



# Degradation Mechanism

The process of degradation happens whenever a change occurs to the main chain, side chain or substituent groups of Nylon molecules. These can happen in any of the forms below:

- Change in one or more end-groups;
- Disruption of the side-chains;
- Chain scission of the backbone.

This can be caused in different ways such as Mechanical, Thermal, Photo- and Chemical degradation.

# Degradation Mechanism



Different parameters cause Nylon to degrade.

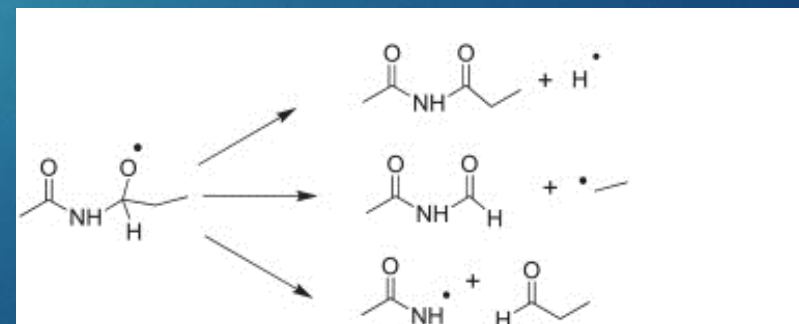
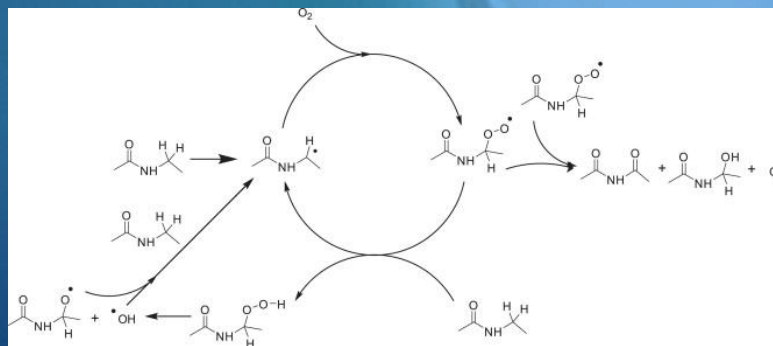
- Intermolecular Forces
- Processing Conditions
- Storage
- UV Radiation
- Weathering
- Heat
- Moisture
- Dyestuff
- Chemicals



# Degradation in Process and Recycling



- Combination of Mechanical forces and heat during processing will result in various changes in the molecular structure of polymers. Chain scission is one of the effects which will produce free radicals.
- Free radicals, due to their highly reactive nature, will react again with Oxygen and result in further degradation.





# Degradation in the Environment

- Under photolytic and/or thermal ageing conditions, Nylon undergoes undesirable changes in mechanical properties, becomes brittle and becomes yellow in color. The behavior of aliphatic polyamides on exposure to heat and irradiation has therefore attracted a significant amount of attention.

# What to do to avoid many of these problems?



- ▶ Use the right grade for every application
- ▶ Find the right processing conditions (rpm, temperature, screw design)
- ▶ Use of appropriate process stabilisers (To avoid degradation during the process)
- ▶ Include the right UV and Antioxidant packages in the formulation (To protect the Nylon molecules from degradation in service life)





One of the solutions is

## Process Enhancer 701

An Innovative Additive Compound for  
Processing & Service Life

- ▶ Let's check some case studies to realise what it is capable of...



# UV Stability

Nylon 6 fibers QUV340 exposure, 380 hrs.  
(8 hrs 70C; 4 hrs 50C Conditioned)



Control

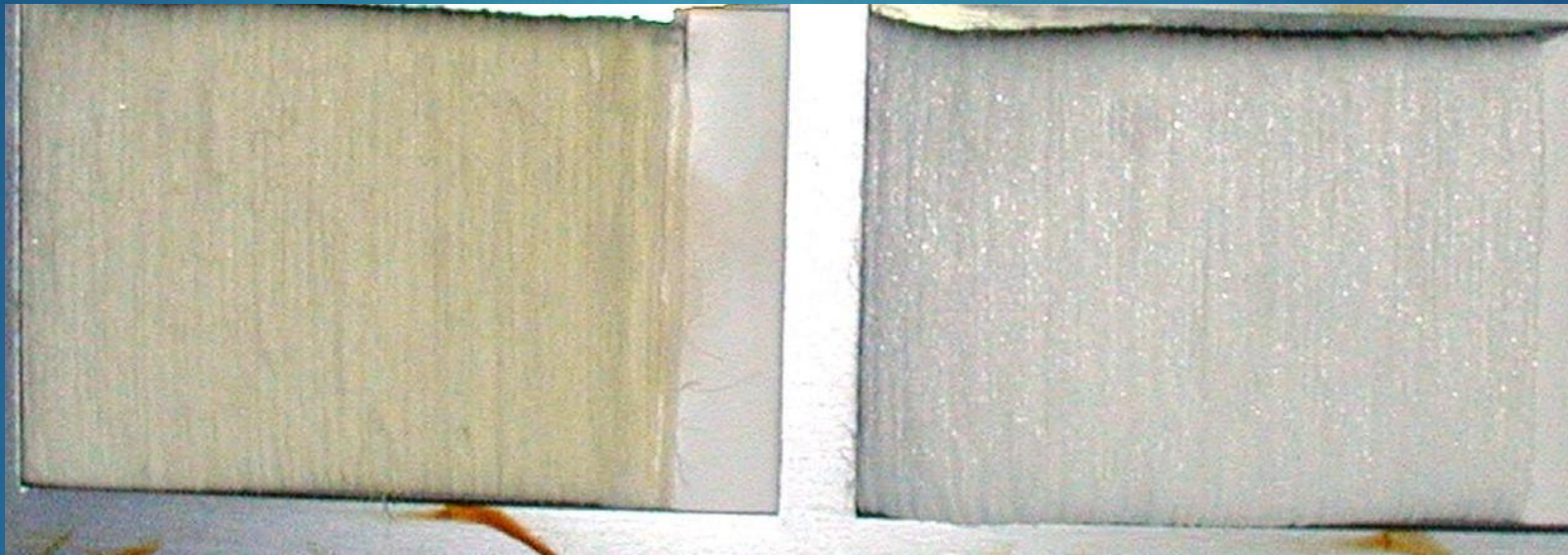
0.28 % 701

0.35 % 701



# UV Stability

Nylon 6 containing 0.5% TiO<sub>2</sub>  
QUV340 exposure, 1200 hrs.



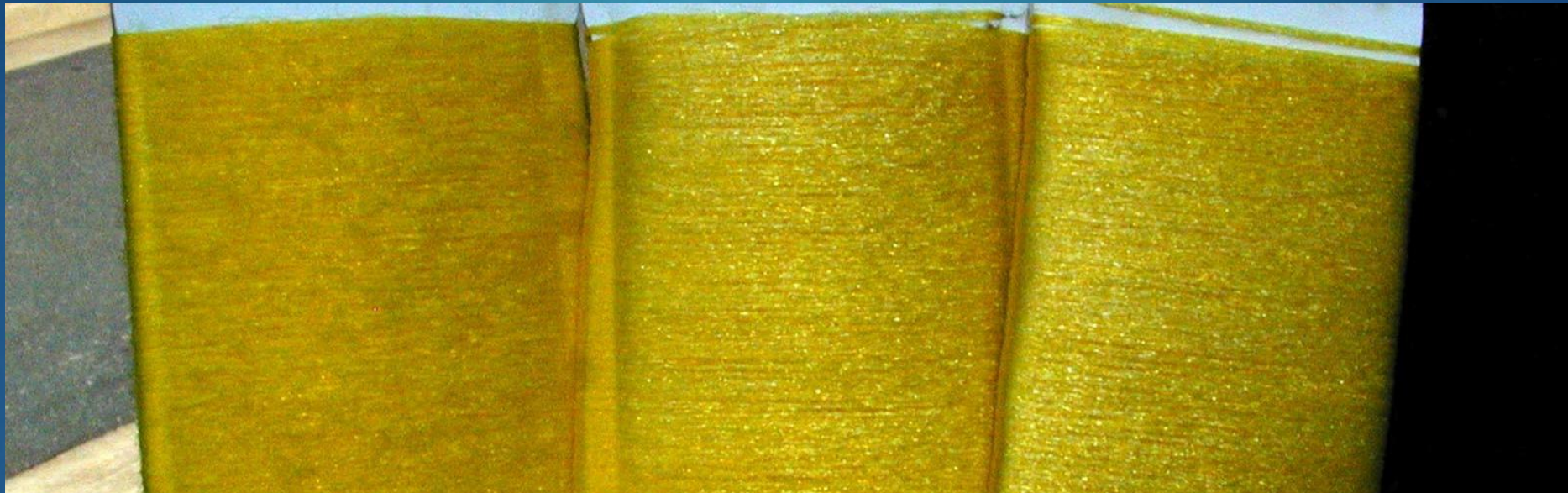
Control

0.35 % 701



# UV Stability

1% Pigment 180 in Nylon 6 fibers,  
QUV340 exposure: 1550 hrs.

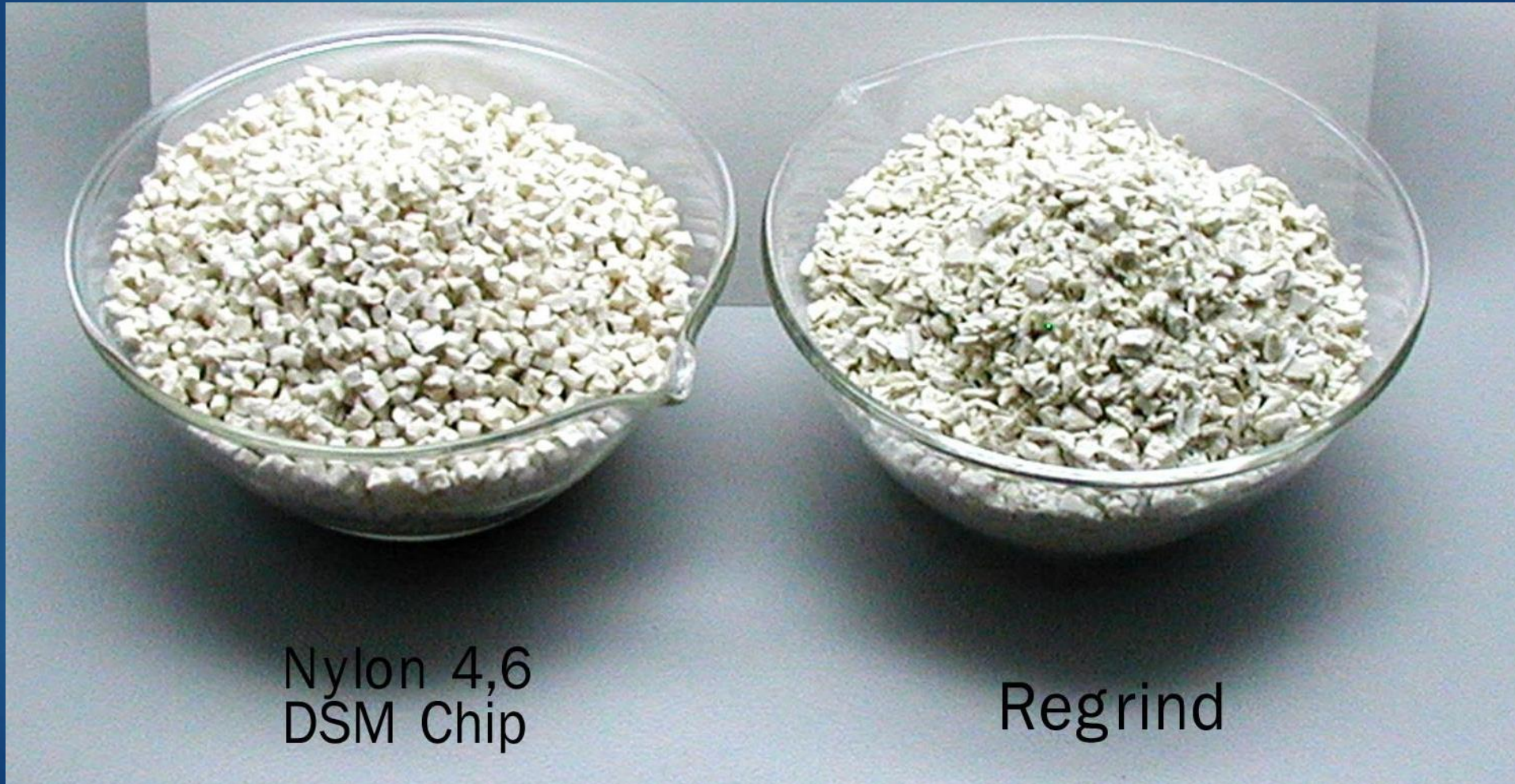


Control  
**DEGRADED**

0.1 % 701

0.2 % 701

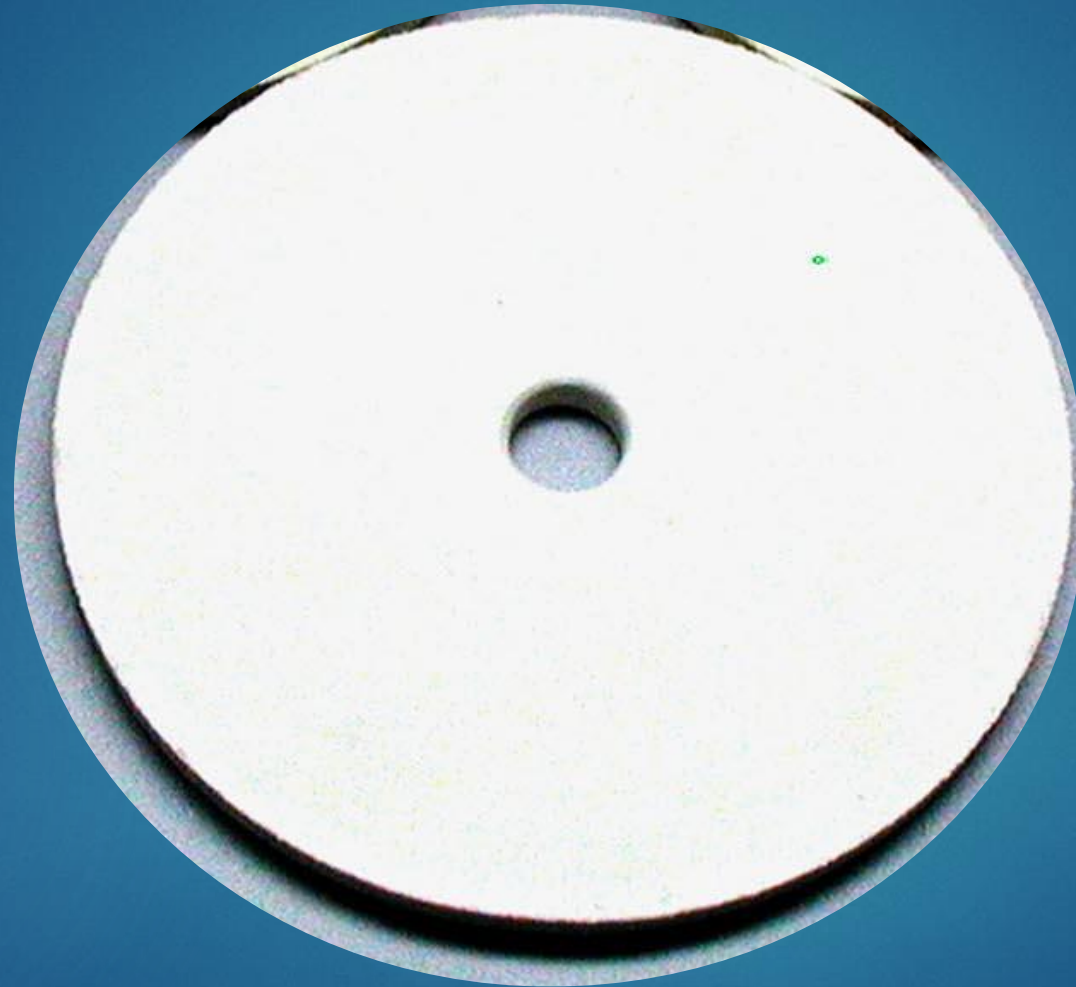
# Injection Molding Trial with DSM Nylon 4,6



Nylon 4,6  
DSM Chip

Regrind

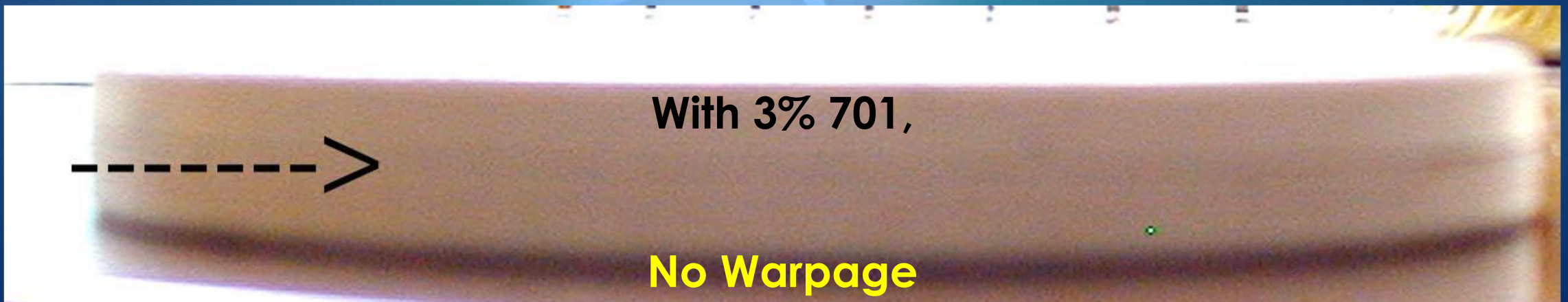
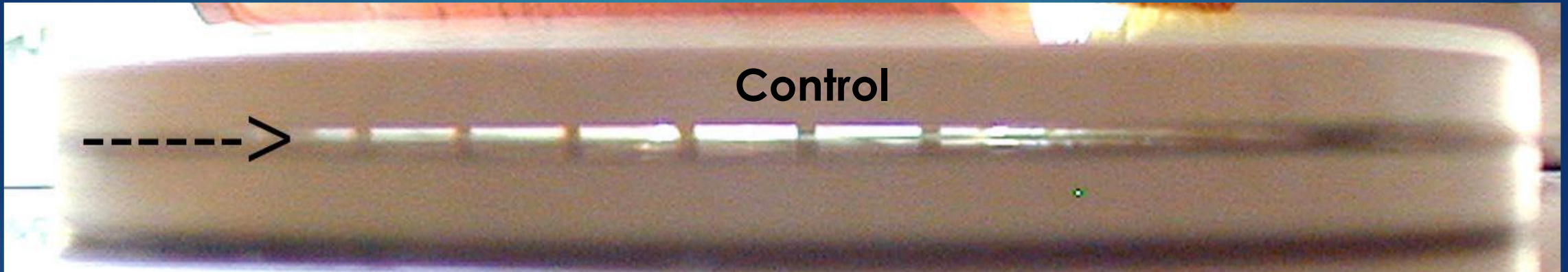
# MOLDING WITH 6:1 RATIO OF PRIME TO RECYCLED NYLON 4,6



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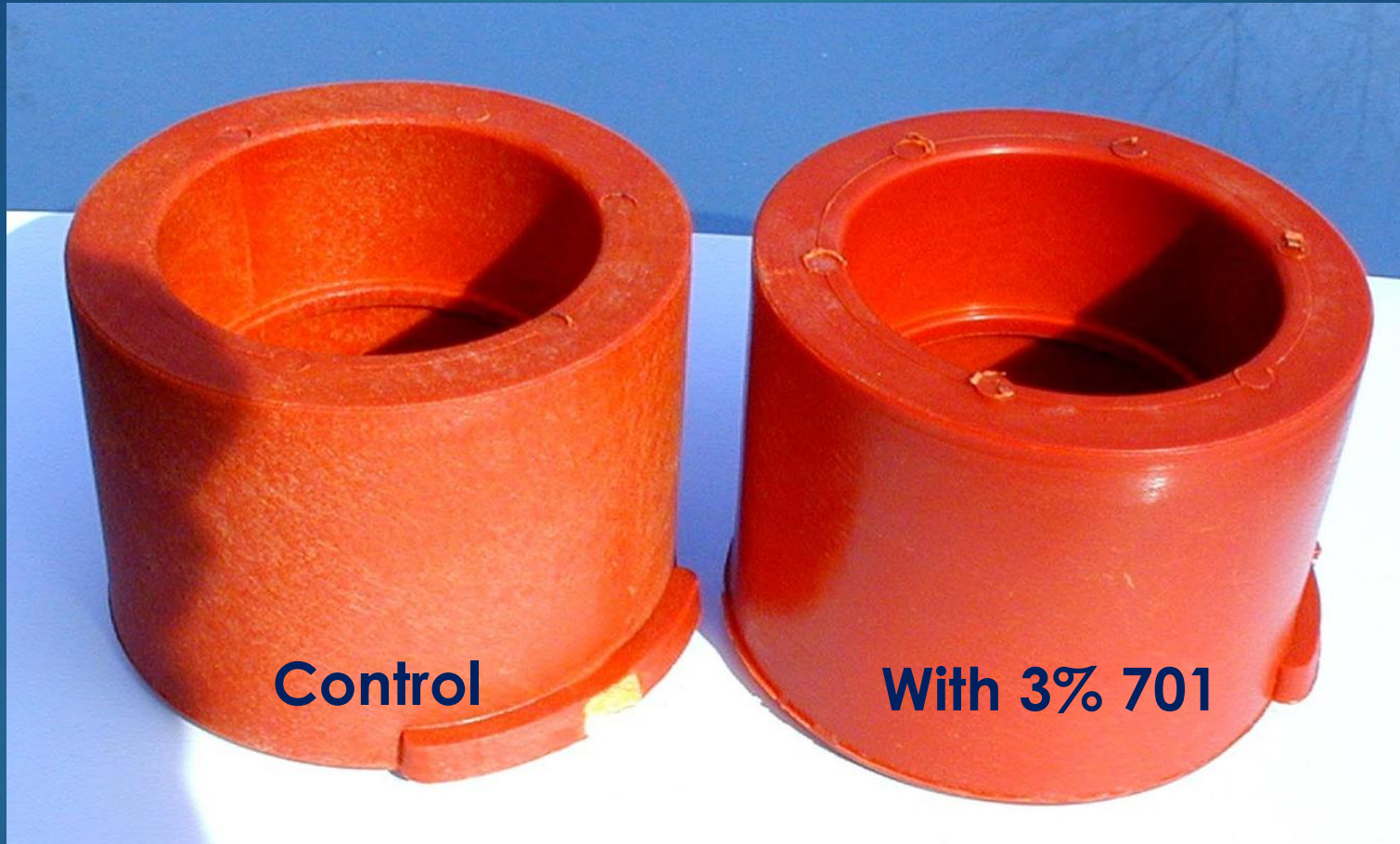


# Warpage



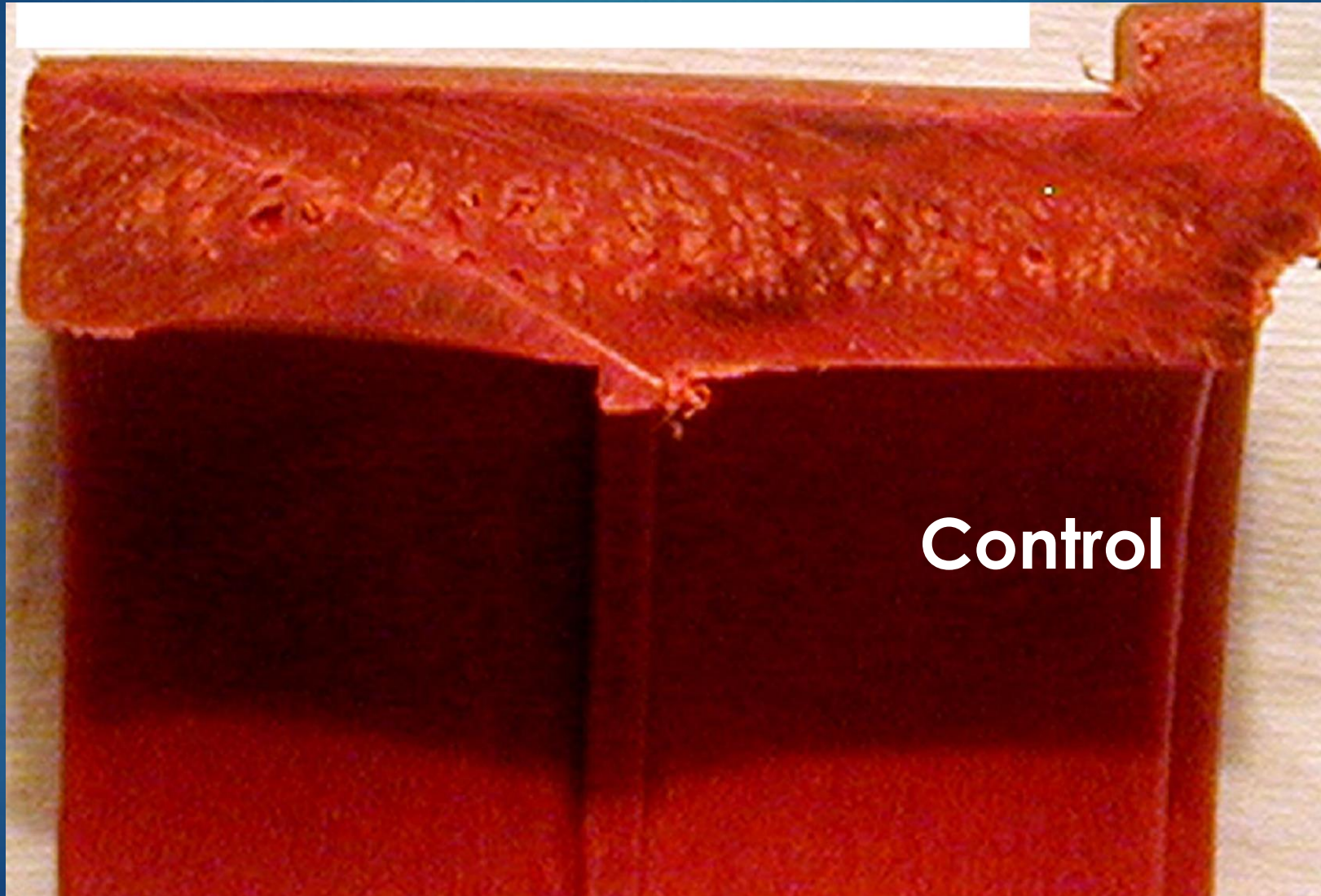


# Nylon 6 with 33% Fiberglass





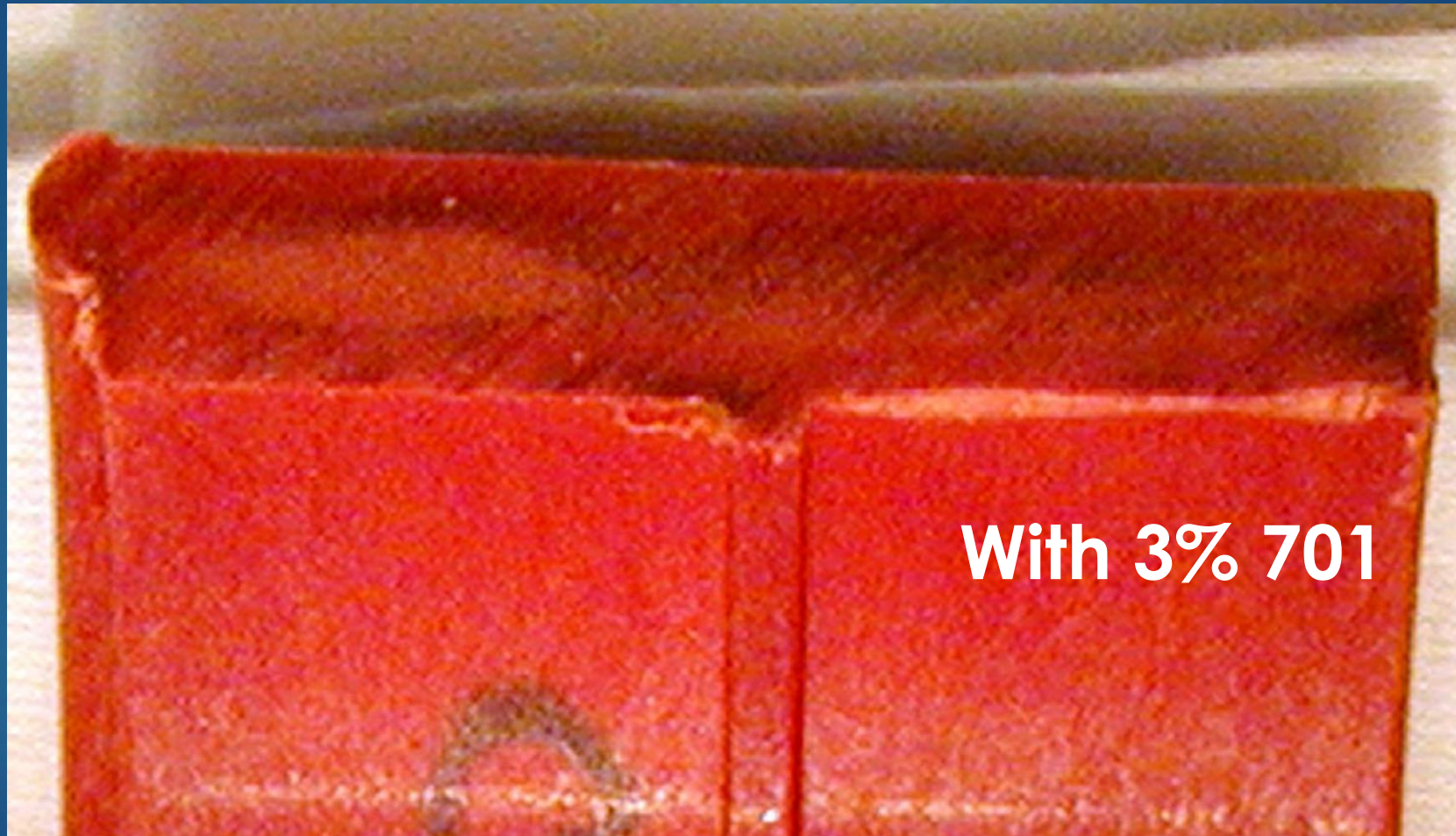
# Nylon 6 with 33% Fiberglass



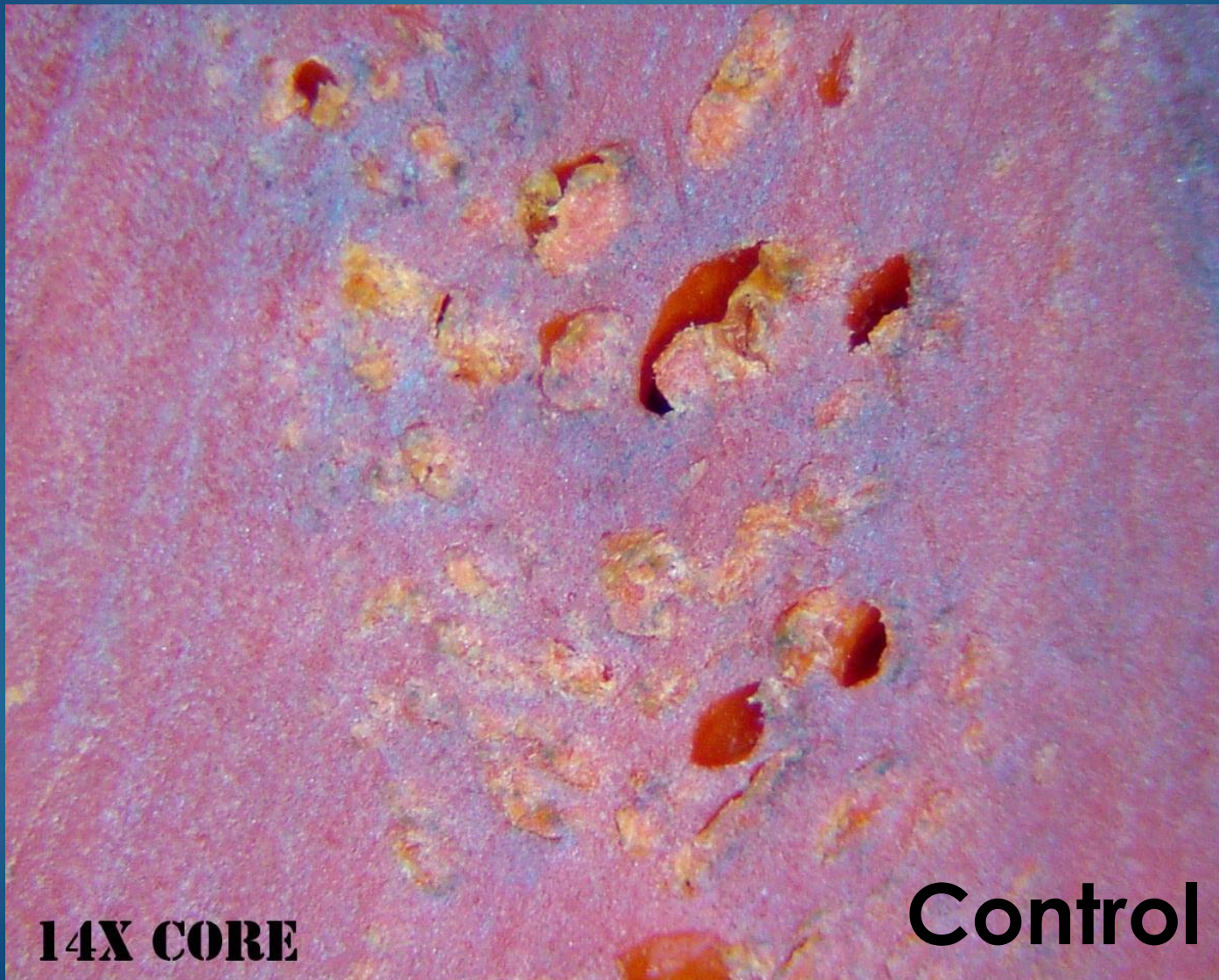
**Control**



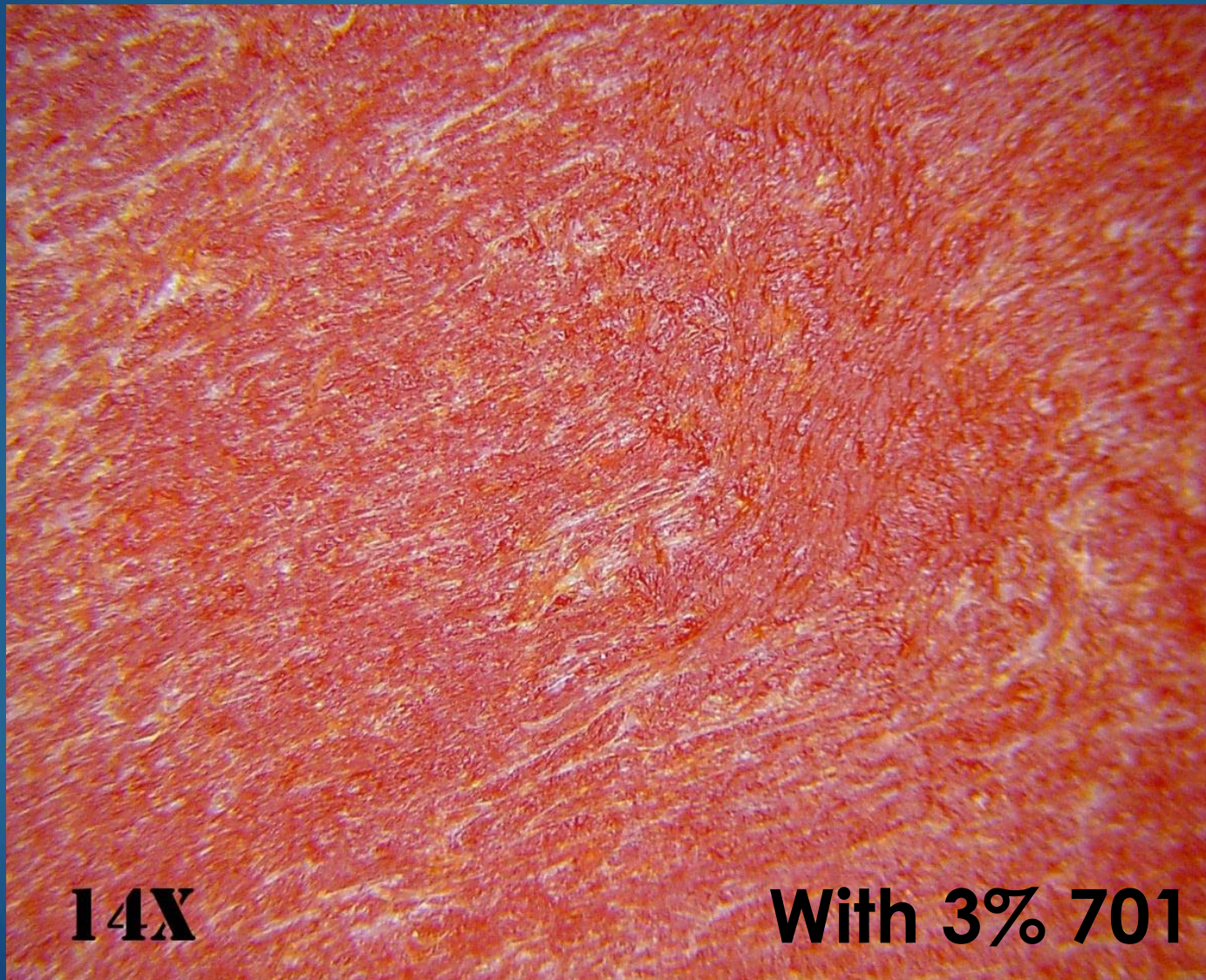
# Nylon 6 with 33% Fiberglass



# Nylon 6 with 33% Fiberglass



# Nylon 6 with 33% Fiberglass



**14X**

**With 3% 701**

# Dupont Zytel 70G33 HSIL 33% Glass Filled Black Nylon 6,6 Molded 310C

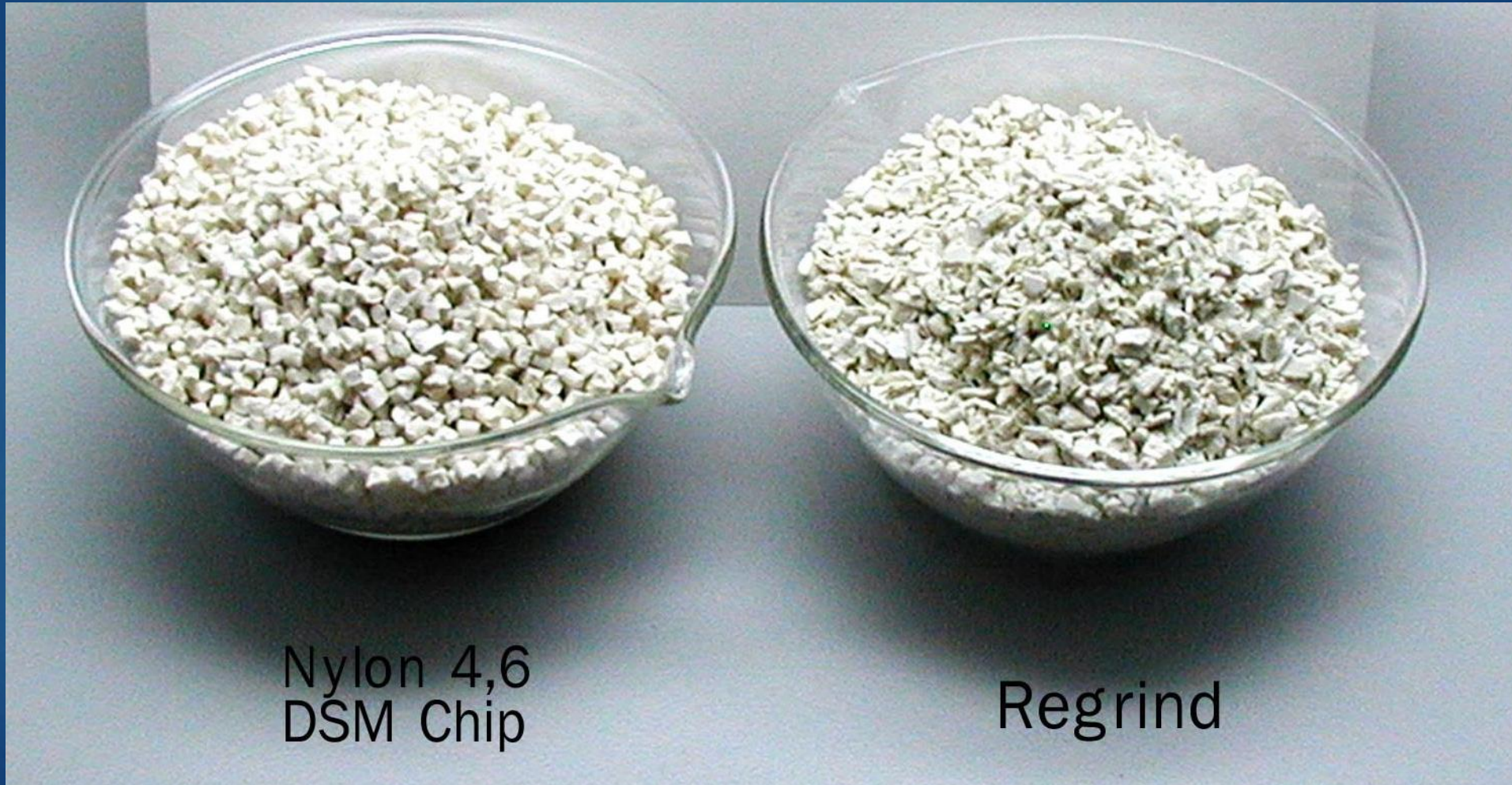


Control



With 2% Cel-Span 701

# Injection Molding Trial with DSM Nylon 4,6 with Regrind Material



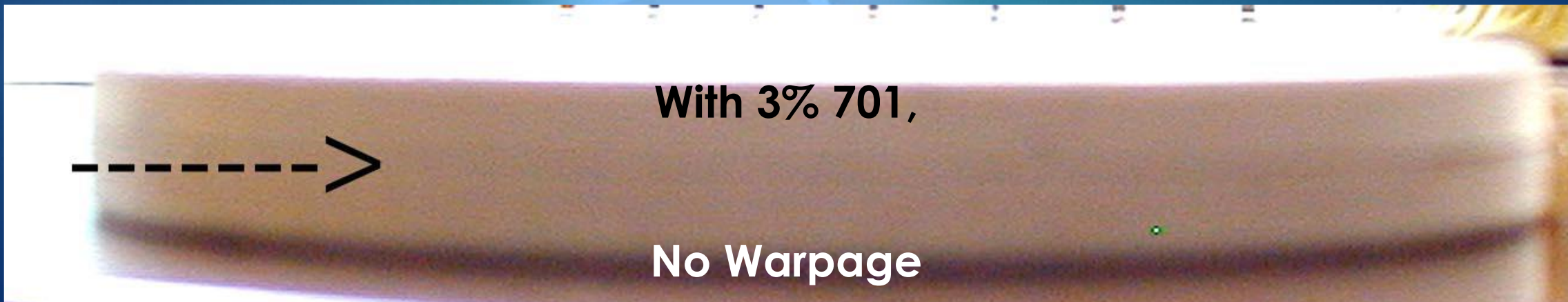
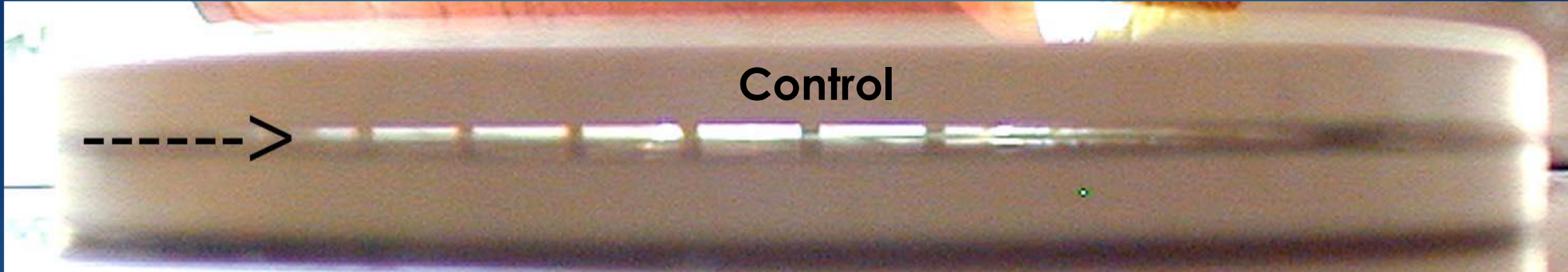
# MOLDING WITH 6:1 RATIO OF PRIME TO RECYCLED NYLON 4,6



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# Warpage







# Advantages of Enhancer 701 in Nylon processing/products

- ✓ **Enhanced Processability**
- ✓ **Extended UV resistance**
- ✓ **Decrease in cycle time**
- ✓ **Reduction in processing temperature (10 to 40F)**
- ✓ **Decrease in Yellowing**
- ✓ **No Warp**
- ✓ **Allows using regrind back into the system**



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