

Molding Quality Parts by Fully Understanding the Processing Window

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Technical Services and Applications Development

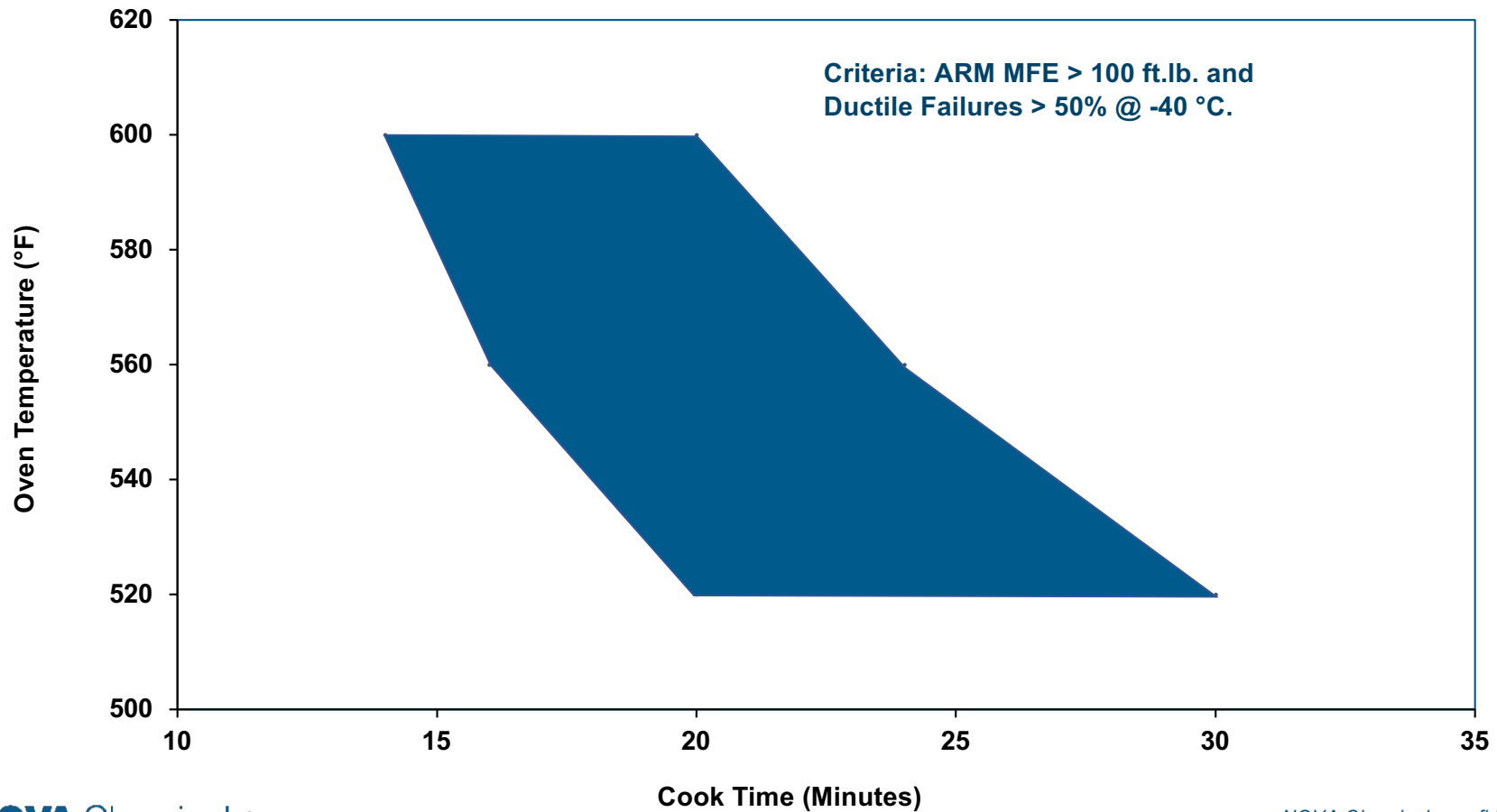
September 2021





Process Window – ARM Impact -40 °C

NOVAPOL® TRx0338-U/UG - Process Window ARM Impact, 0.250 inch Samples





Rotomolding Applications



Benefits to molding quality parts:

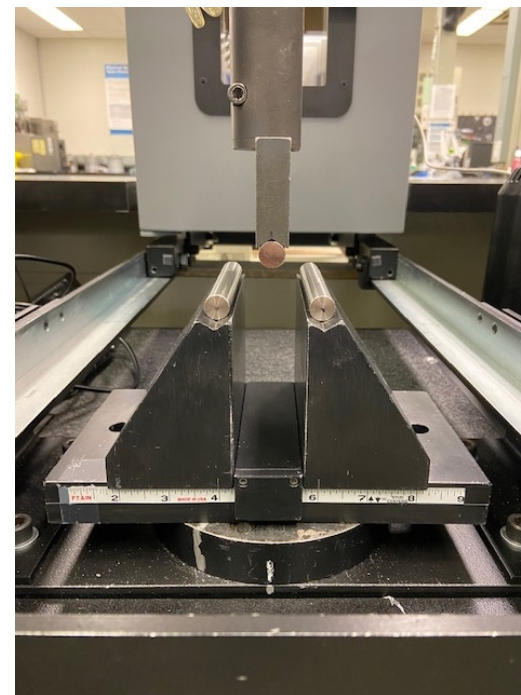
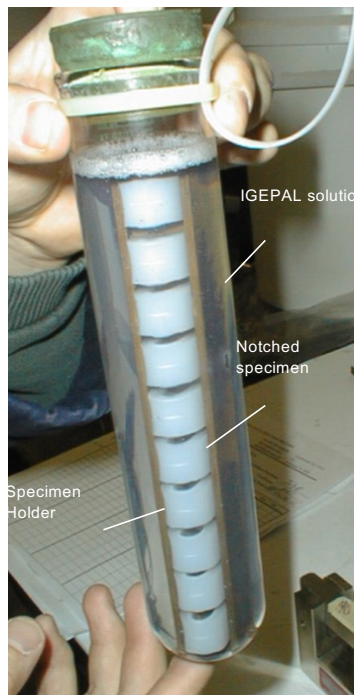
- Confidence in long term properties such as ESCR and UV stability
- Lower scrap rates
- Better performance in demanding applications such as kayaks



Internal Study

Scope

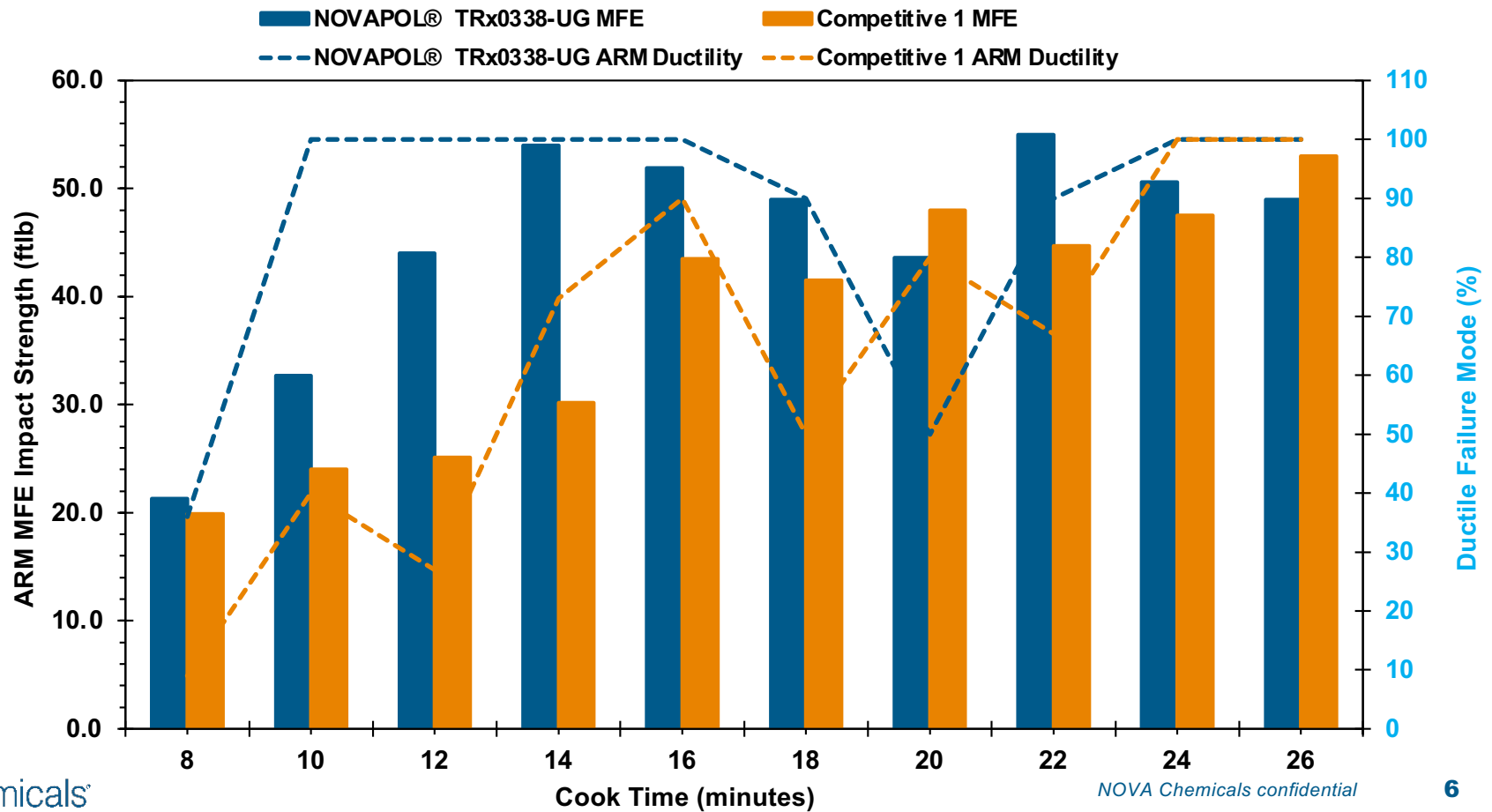
- 2 PE grades 3 melt/0.938 density resins.
- 35 mesh powder.
- Oven Temperature 560 °F.
- Range of cook times.
- 0.125-inch samples. Test Box mold.
- ARM Impacts & “As Molded” density.
- Environmental Stress Crack Resistance (ESCR), Condition A.
- Flexural Modulus, 3-point bend test.
- FTIR and microscopy.
- Accelerated weathering (WOM), long term test.





Process Window at 560 °F Oven Temperature

ARM Impact Properties vs. Cook Time, 0.125 inch Samples





On Set Time

ARM Impact Properties vs. Cook Time, 0.125 inch Samples

Criteria:

— MFE ≥ 30.0 ftlb

and — Ductility $\geq 50\%$.

On set time:

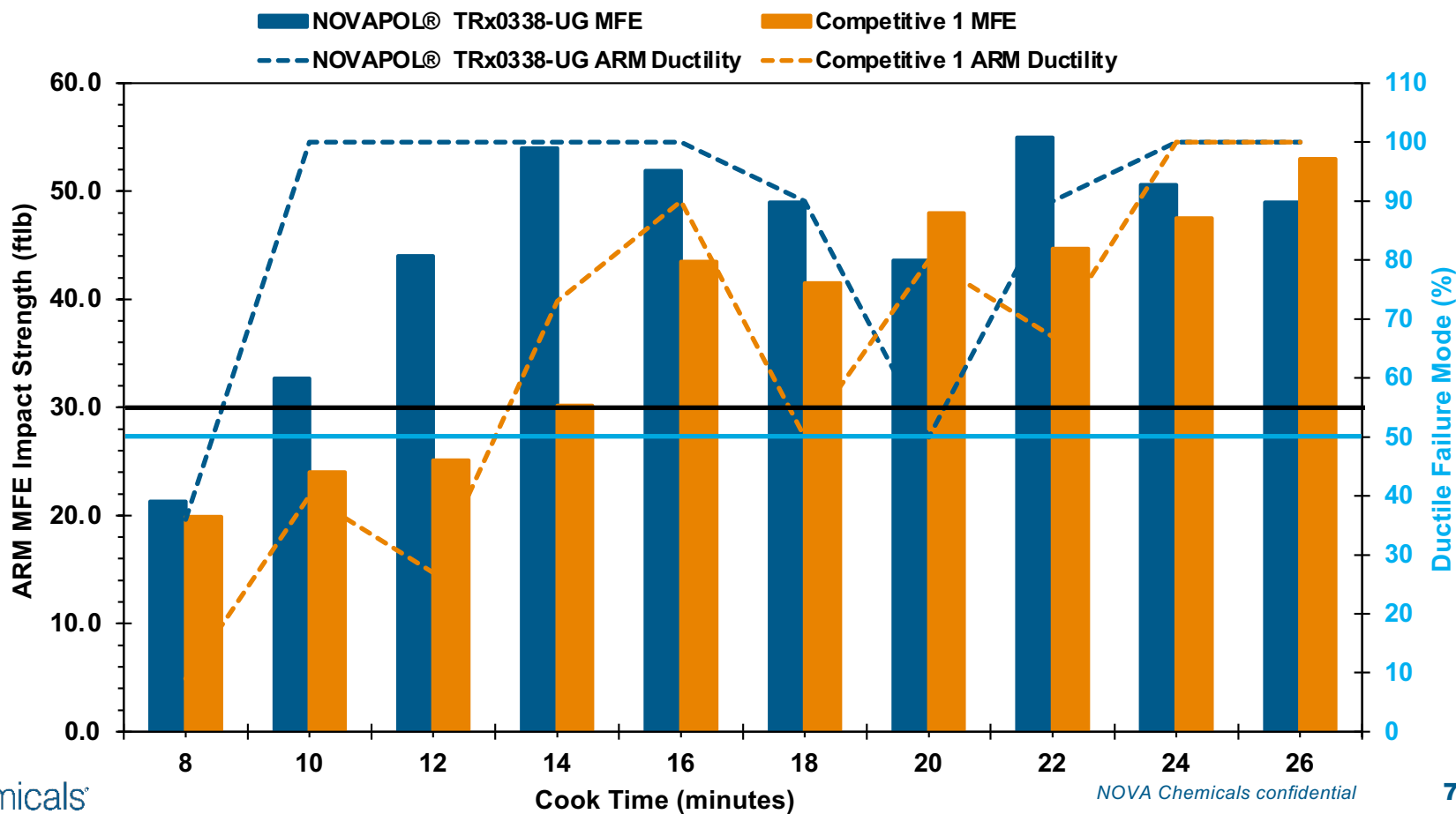
NOVAPOL®

TRx0338-UG

12 minutes.

Competitive 1

16 minutes.

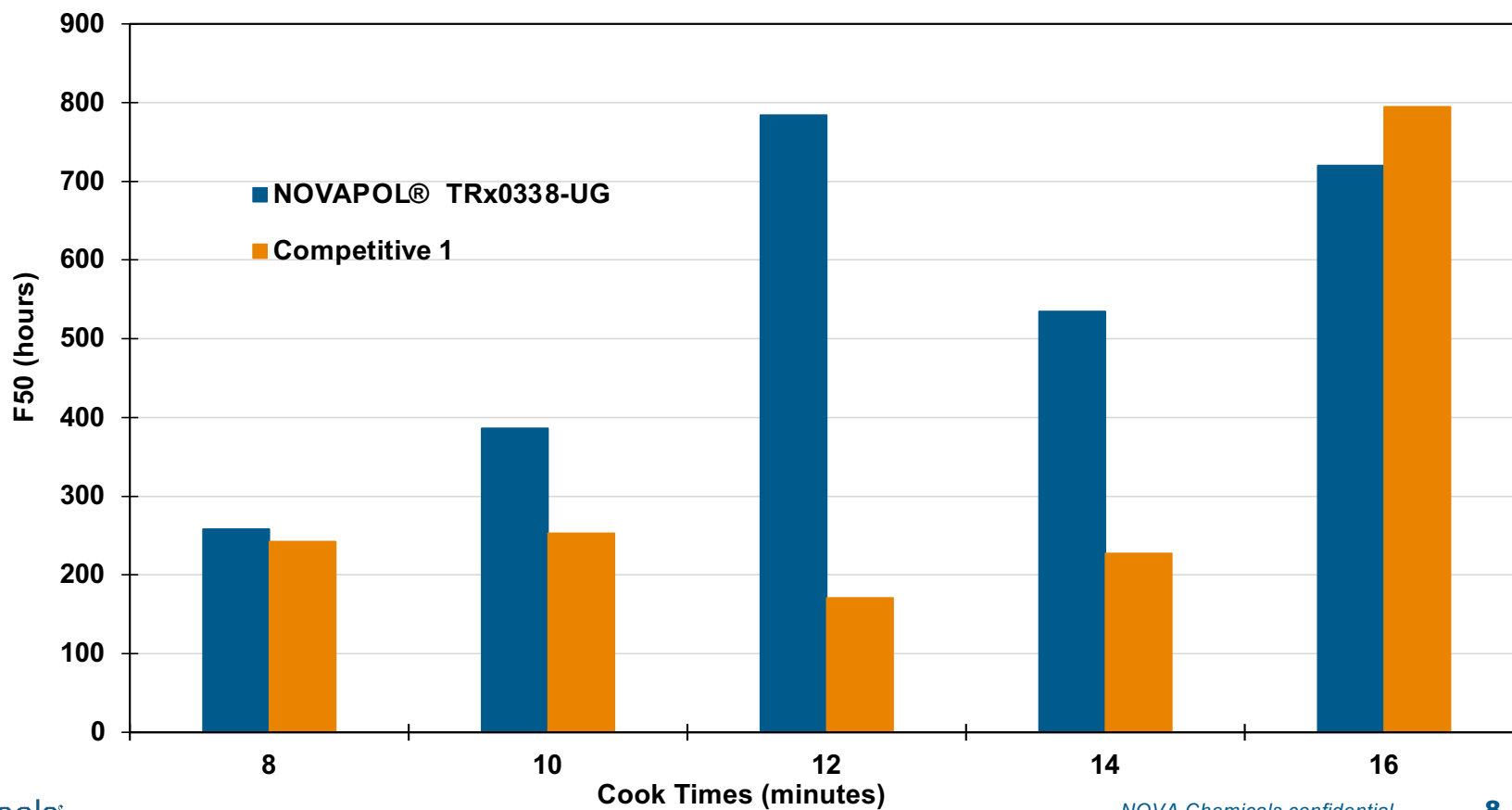




Environmental Stress Crack Resistance

ESCR Condition A, 10% solution no notch

On set time:
NOVAPOL®
TRx0338-UG
12 minutes.
Competitive 1
16 minutes.

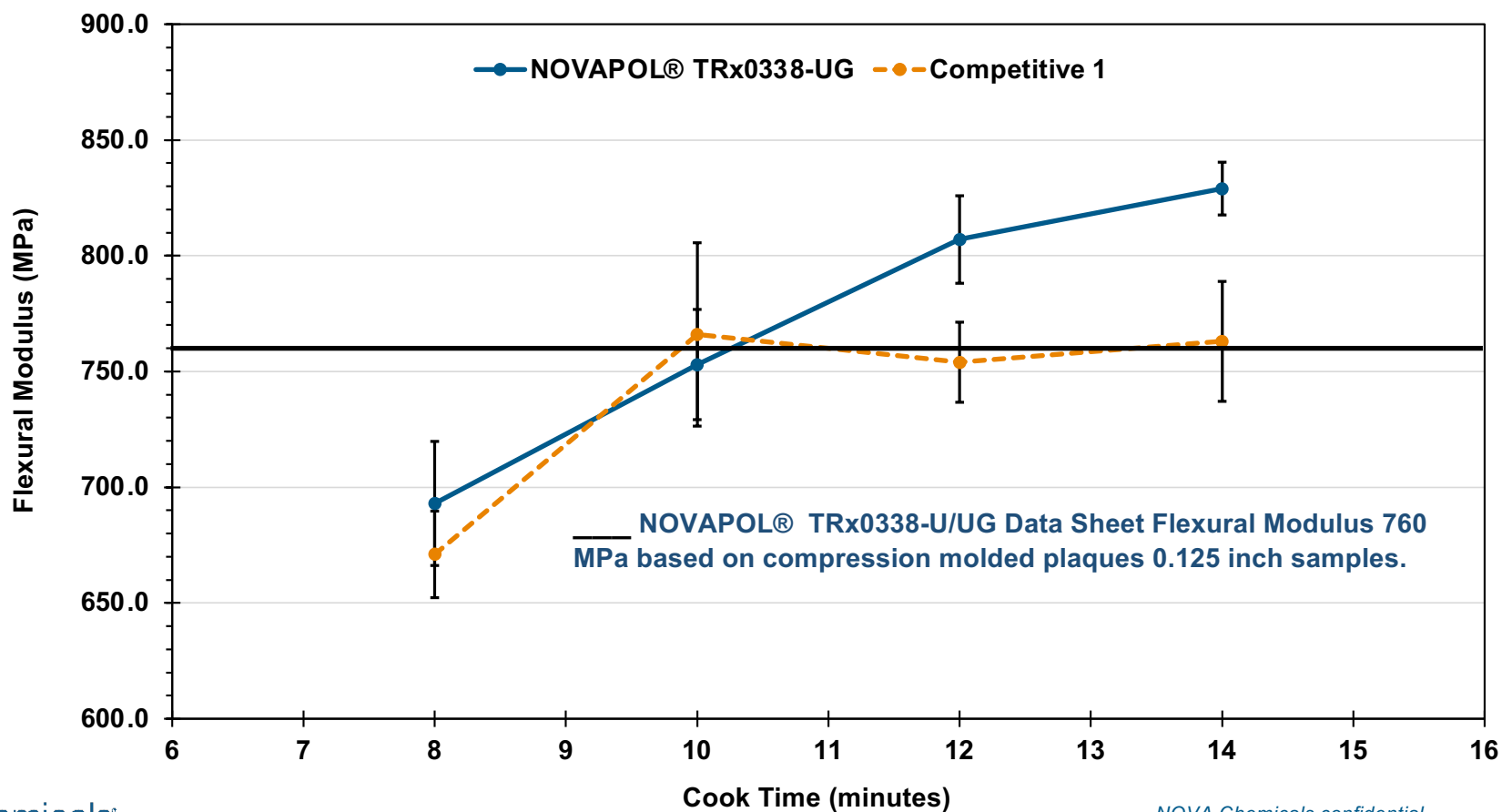




Flexural Modulus

On set time:
NOVAPOL®
TRx0338-UG
12 minutes.
Competitive 1
16 minutes.

Flexural Modulus 1% Secant Modulus vs. Cook Time, 0.125 inch Samples





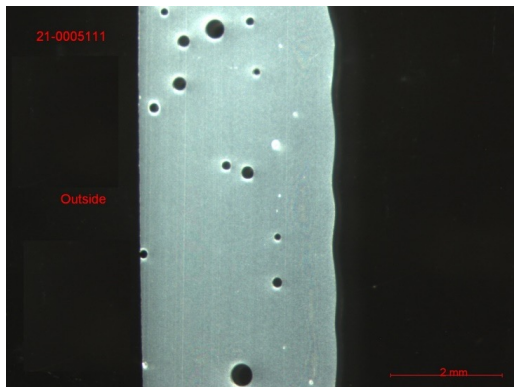
Cause and Effect Relationships



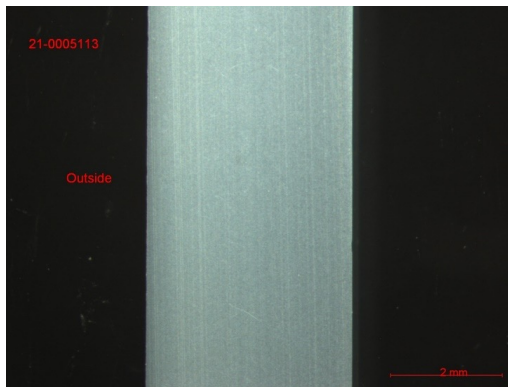
Optical Microscopy

Disappearance of bubbles corresponds to increase in MFE and ductility > 50%

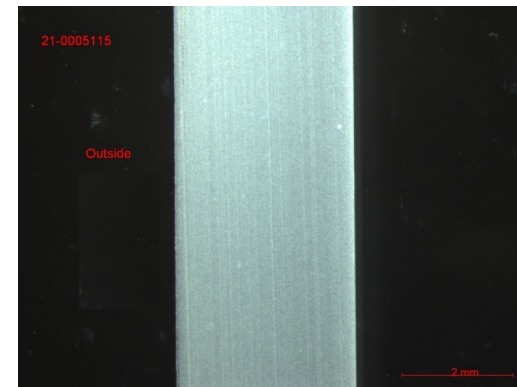
**NOVAPOL®
TRx0338-U/UG**



8-minute cook time

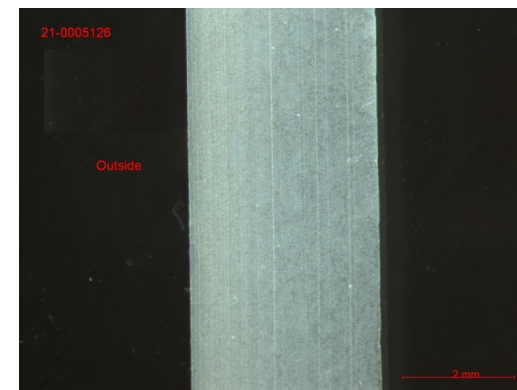
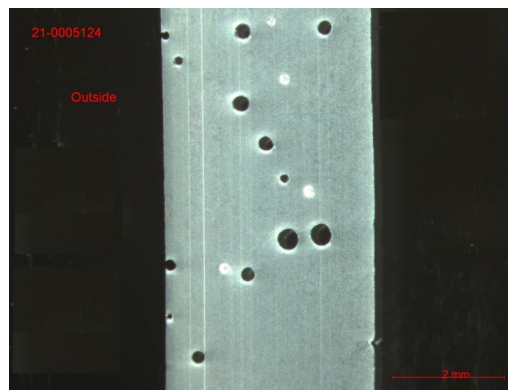
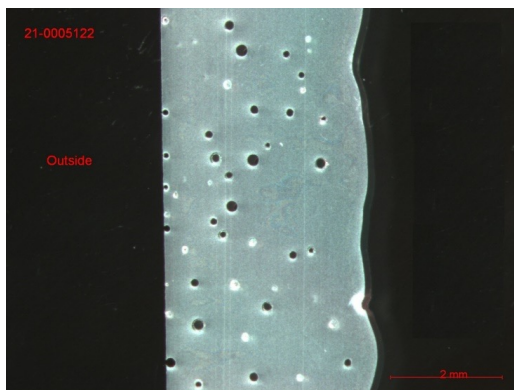


12-minute cook time



16-minute cook time

Competitor 1

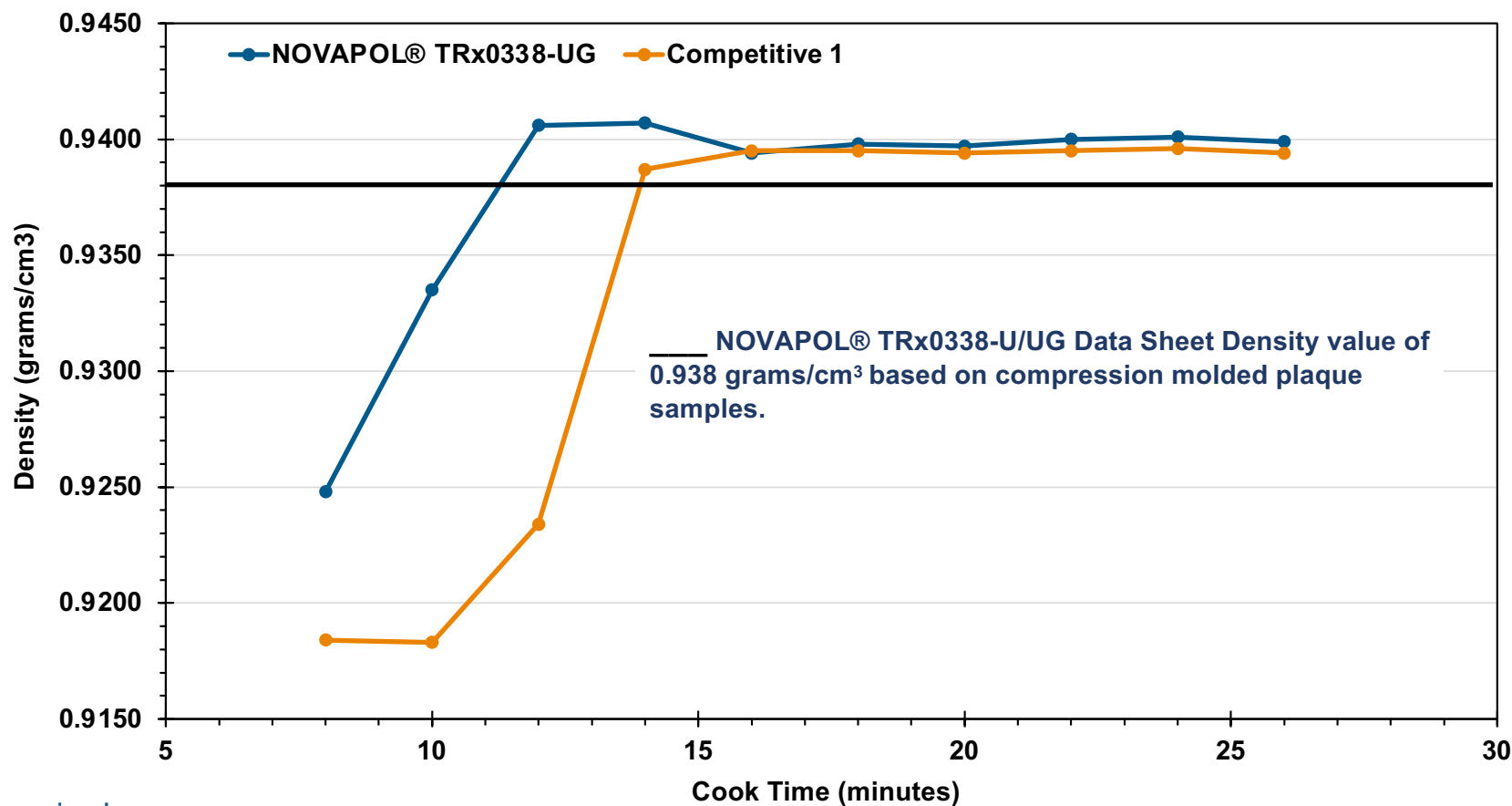




As Molded Density




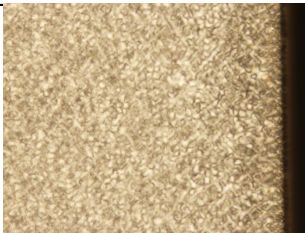
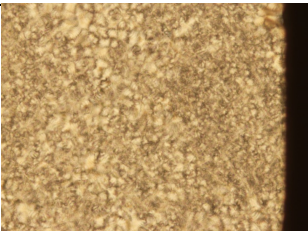
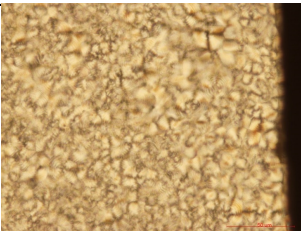
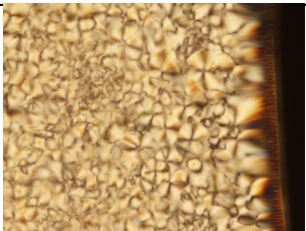
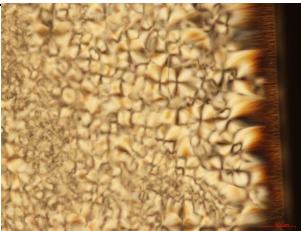
On set time:
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TRx0338-UG
12 minutes.
Competitive 1
16 minutes.

As Molded Density vs. Cook Time, 0.125 inch Samples





Polarized Light Microscopy, Inner Surfaces

Resin	Cook Times (minutes) and Comments			
	12	16	20	24
NOVAPOL® TRx-0338-U/UG				
	12-minute cook is the on-set time for TRx0338-UG. Competitive resin exhibits coarser morphology.	Competitive resin continues to have uneven spherulites. 16-minutes is the on-set time.	At 20 minutes indications of degradation inner layer for both materials.	Cook time corresponds to recovery in impact ductility.
Competitive 1				



Summary

- Have a clear understanding of the end use quality and performance requirements. Often it is more than just impact that is important to the end user.
- Pay attention to cure. Good correlation between good cure levels and impact strength, ESCR performance and part stiffness.
- Voids/bubbles act as stress concentrators.
- Degradation mechanism likely explains the variability in impact performance for over cured parts.

Materials with broad process windows are the molders' best friend.



Acknowledgments

- NOVA Chemicals Centre for Performance Applications
- Project team members, Celine Bellehumeur and Henry Hay



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