



INEOS Next Generation
Arotran™ Structural Technology
ACCE Conference 2019

Outline

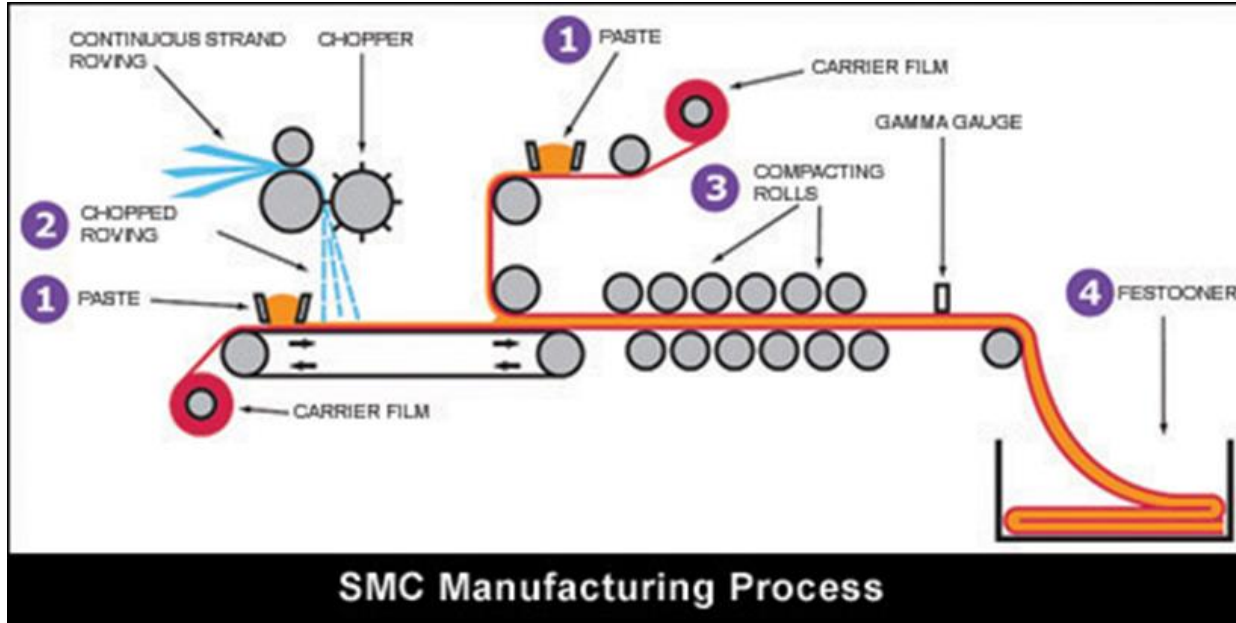
- Sheet Molding Compound (SMC) Overview
- Development Objectives
- Next Generation Arotran™ Structural Technology (NGAST) for Battery Enclosures
- Next Generation Arotran™ Structural Technology (NGAST) for Truck Boxes

Background

History Of INEOS Composites

- Our transportation brands, like Arotran™ and Derakane™, are used for long list of automotive and heavy truck BMC and SMC applications
- Part of the INEOS family
- Constantly creating new resin systems and families to meet the industry's newest applications, like battery enclosures and truck boxes

What Is SMC?



Benefits- Why Do We Use SMC?

- **SMC's Advantages in Automotive Applications = Cost and Flexibility**
 - Lower tooling cost when compared to aluminum or steel
 - Lower scrap rates over other composite techniques
 - Corrosion resistant
 - Fast button to button cycle times
 - Excellent strength to weight ratio
 - Lighter weight parts as compared to metals
 - Ability to consolidate multiple parts
 - Increased part complexity possible ex. - difficult compound curves



Research Goal

- **Develop Advanced Resin Systems for Battery Enclosures and Truck Box Applications**
 - That have vinyl ester like high performance mechanical properties without the vinyl ester cost
 - That have the ability to accommodate a wide range of reinforcement, additives, and fillers
 - That can be used for high strength, light weight, and weatherable applications
 - That retain all the traditional SMC benefits

Next Generation Arotran™ Structural Technology (NGAST) For Battery Enclosures

Advanced Resin System - Applications-Battery Enclosures

- **Electric Vehicle Battery enclosures**
 - Emerging market, but composites appear to be the material of choice
 - Electrical insulation
 - Flame resistant
 - Light weight
- **INEOS is working on developing resin systems for highly filled applications for flame resistances and low part specific gravity**



Source: CSP

V0 Testing of Experimental Battery Enclosure Resin

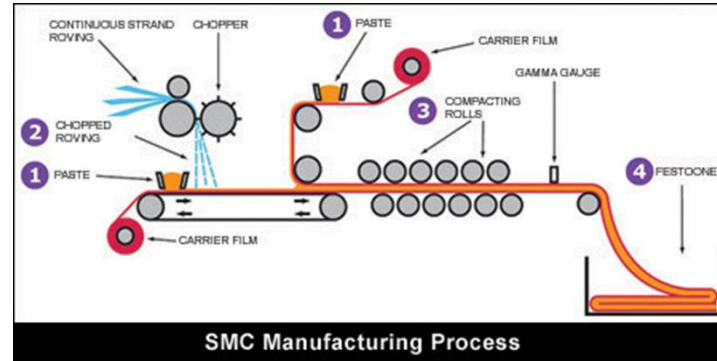
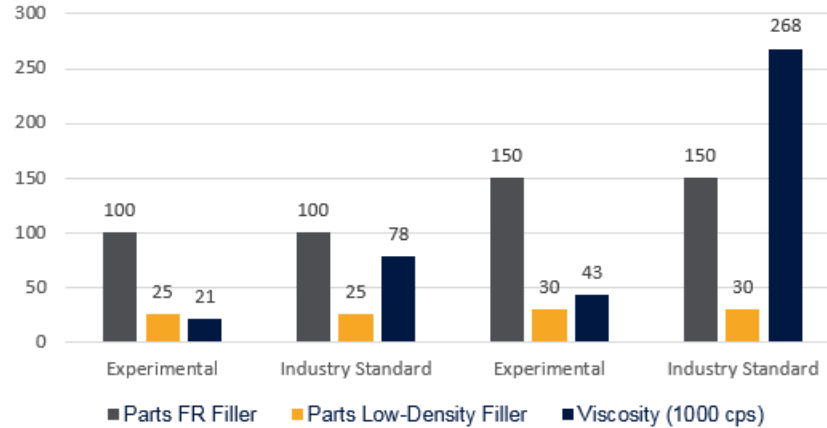
Base Resin	SMC Panel Testing				
	Parts Flame Resistant Filler	Parts Low-Density Filler	Part Specific Gravity	Processable	Passes Flame (V0) Testing
Experimental	100	25	1.34	Yes	No
Experimental	150	30	1.43	Yes	Yes
Industry Standard	100	25	1.19	Yes	No
Industry Standard	150	30	1.36	No	N/A

- Battery Enclosures require a large addition of dense filler to meet flame requirements
- NGASt technology allows for this to be offset by adding low-density filler, which would traditionally not be processable

Viscosity Testing of Experimental Battery Enclosure Resin

- These high filler levels are achievable by designing a resin system that can incorporate a large amounts of solids
- When the paste viscosity reaches a certain maximum, it is not processable with traditional SMC lines

Viscosity and Filler Loadings



Next Generation Arotran™ Structural Technology (NGAST) For Truck Boxes

Advanced Resin System - Applications - Pickup Bed

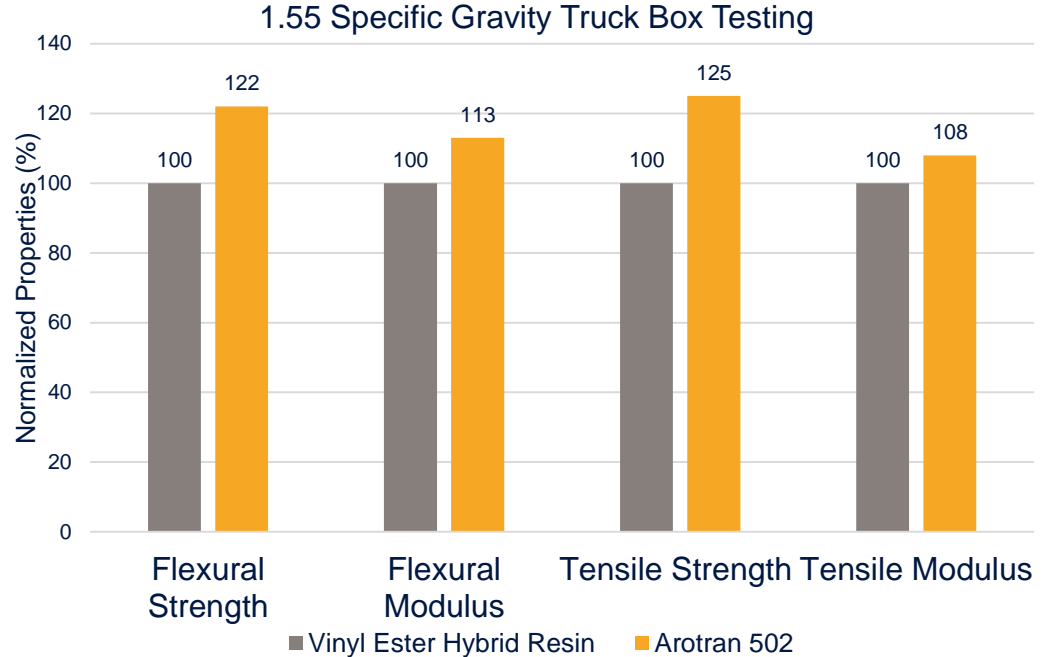
- **Composite Truck Boxes**
 - Lighter weight than their metal counterparts
 - Provide design freedom and part consolidation
 - Can be painted or use weatherable in-mold color
 - In-mold color provides mar resistance and manufacturing advantages
- **INEOS has developed two new advanced resins for this market**
 - Arotran™ 502 – painted applications
 - Arotran™ 808 – in-mold color applications



Source: CSP

Arotran™ 502- SMC Benchmarking vs Commercial Products

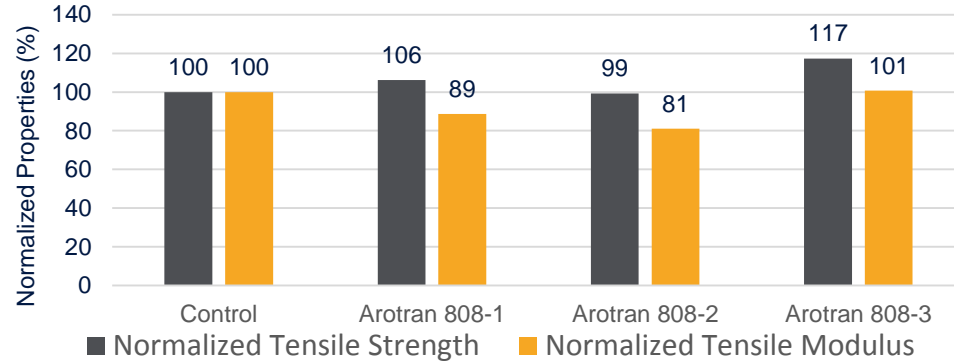
- For painted truck box applications
- Provides higher properties than a current vinyl ester hybrid based truck box in SMC mechanical testing
- Over 22 % improvements in strength, modest gains in modulus



Arotran™ 808 for High Strength, Mid Density Applications

- In-mold color applications
- Control is not processable at 1.55 specific gravity and 37 % fiber volume fraction
- Arotran™ 808 can process higher amounts of solid materials
- 1.52 SG part represents an estimated 35 % weight savings over metal

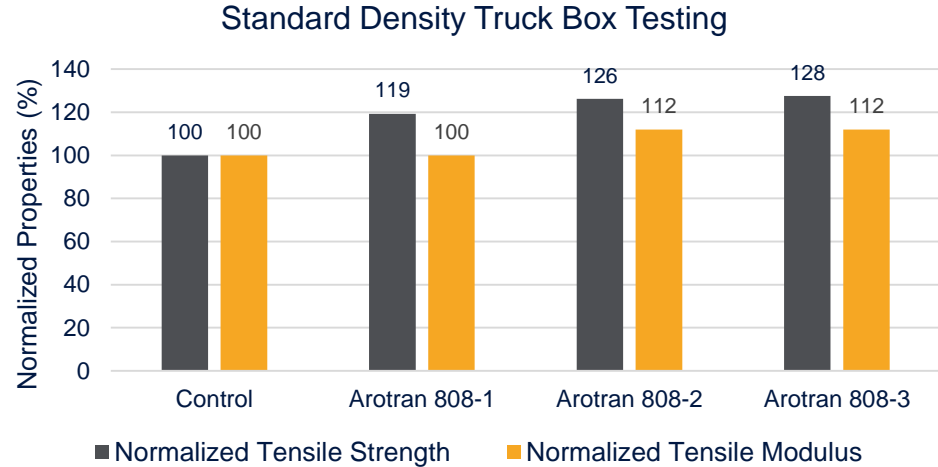
Sub 1.60 Specific Gravity Truck Box Testing vs. 1.77 Specific Gravity Control



Base Resin	SMC Panel Testing		
	Part Specific Gravity	Fiber Glass (Volume %)	Engineered Filler (Volume %)
Control	1.77	39	0
Arotran 808-1	1.58	37.7	14.3
Arotran 808-2	1.56	37.8	17.4
Arotran 808-3	1.52	36.5	20.8
Control*	1.55	37.0	13.7

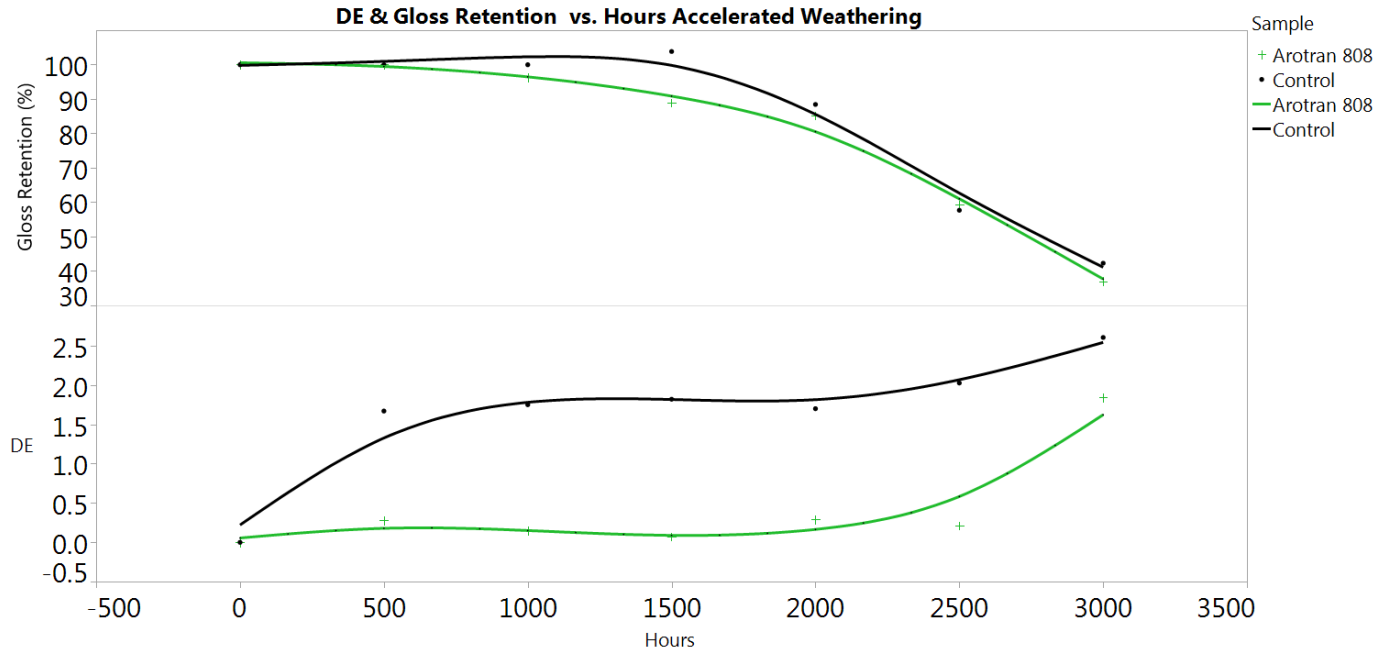
Standard Density, High Strength Truck Boxes

- Alternatively, larger amounts of fiber reinforcement for increased mechanical performance can be used
- This allows for more durable or thinner and lighter parts
 - Estimated 38 % weight savings over metal



Base Resin	SMC Panel Testing		
	Part Specific Gravity	Fiber Glass (Volume %)	Engineered Filler (Volume %)
Control	1.75	37.5	0
Arotran 808-1	1.64	41.4	12.3
Arotran 808-2	1.67	43.3	11.9
Arotran 808-3	1.7	45.1	11.5

Weathering Resistance of Arotran™ 808



- Accelerated weathering testing is a key parameter for in-mold color resins
- Arotran™ 808 can exceed or meet the current industry standard in performance

Conclusions

Conclusions

- **INEOS has developed a new series of resins designed for battery enclosures and truck box applications**
 - Arotran™ 502 for structural systems and Arotran™ 808 for in-mold color applications
 - They deliver vinyl ester like high performance properties at a lower cost
 - They provide significant formulation advantages, like the ability to add high amounts of filler at high volume fractions of reinforcement
 - While retaining the traditional advantages of SMC

Acknowledgements

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Composites