Low VOC and Low Odor Resin Designed for Liquid Compression Molding Application

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Background

- Ability to expand the use of thermoset resins in automotive interior application has been limited by:
  - OEM interior air quality requirements
  - Consumer feedback on odor emissions
  - Health concerns from exposure to VOC's (volatiles organic compounds) like benzene
  - Need for a post molding oven bake step

- Ashland has developed an extensive list of products for low emission applications:
  - Arotran™ 600 series for SMC application
  - Aropol ™ L 65333 LSE series for open mold applications
  - Derakane ™ SIGNIA ™ EVER resin series for corrosion applications
  - Arotran ™ 900 series for monomer free prepreg applications

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Background

- Industry interest in low VOC and low odor resins has extended to the LCM (Liquid Compression Molding)processes
- LCM processes have produced automotive grade parts for a number of years
- The LCM process has distinct benefits
  - Fast cycle times
  - High fiber content
  - No fiber flow
  - Ability to use both directional and chopped fiber

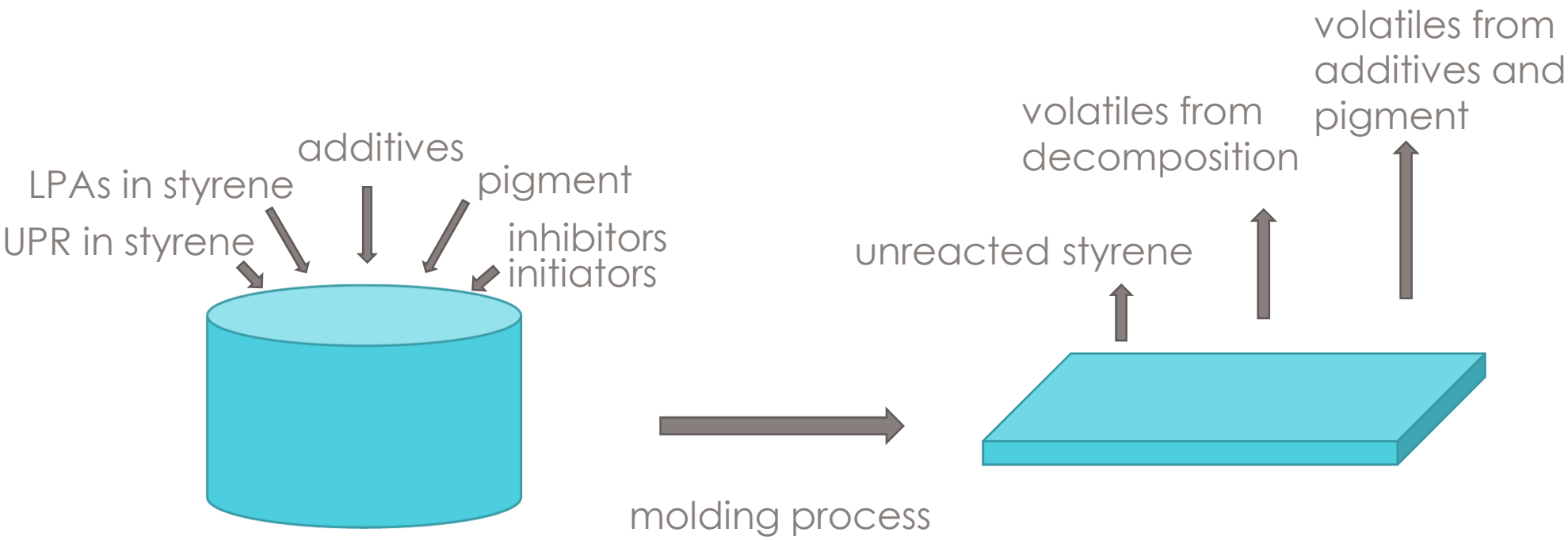
This paper will explore the next steps Ashland has taken to further expand the low VOC low odor material for Liquid Compression Molding applications

Objectives

Develop an affordable LCM resin for structural part application. Parts made of the resin solution should

- offer significantly reduced styrene voc, total voc and odor.
- have similar mechanical properties and thermal properties of parts made with standard LCM resin.
- have desired surface appearance, and be suitable for making low density part.

Sources of VOCs



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Technical Approaches

- Reduce styrene % in resin
- Proper select alternative diluents and loading
- Proper select LPAs and additives
- Drive styrene conversion to more complete during process

Resin Systems

LCM Resin	Base Resin		Filler + Additives	Promotion Package
	% Styrene	% Alternative Diluents		
Control (A)	44	0	control	control
B	26	22.5	control	control
C	31.4	11	simplified	reactive
D	31.4	11	simplified	reactive

- Different alternative diluents used in B, C and D
- Resin viscosities ranging from 6,000 cps to 14,000 cps
- Thix index between 1.4 to 1.7
- All suitable for a typical LCM process

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Panel Properties

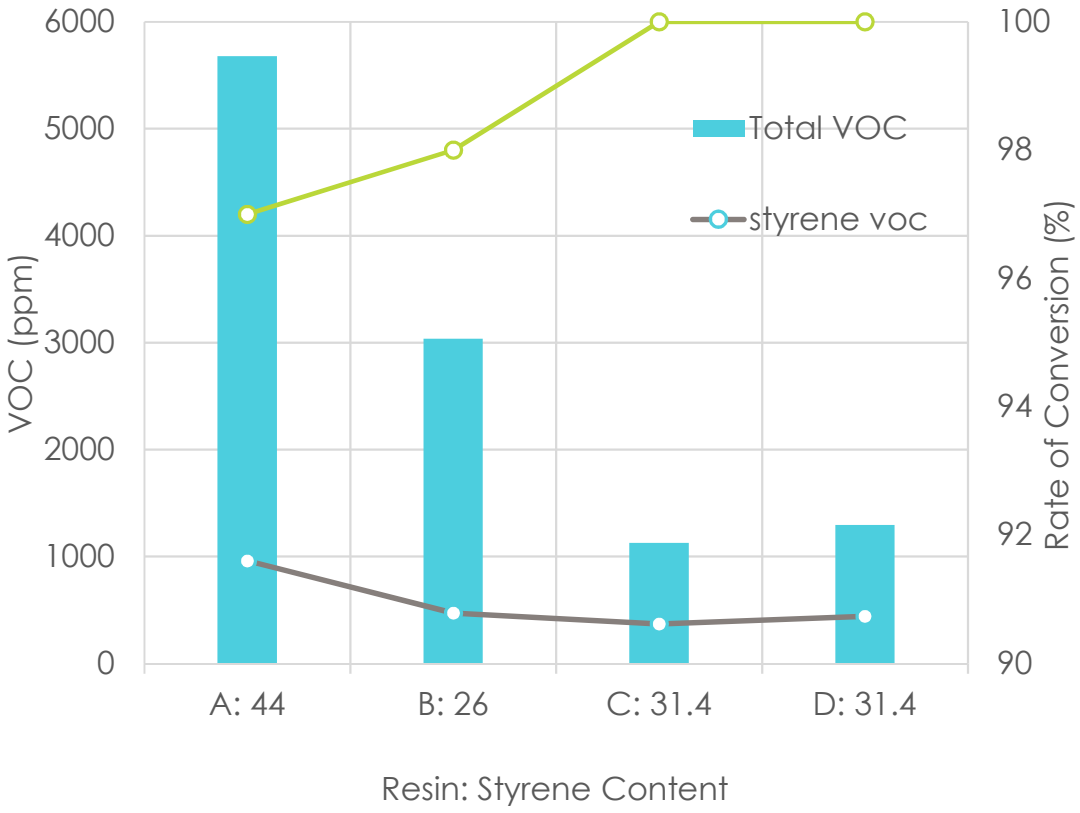
LCM	Density (g/cm ^{3})	ALSA Index	Shrinkage (%)
Control A	1.25	124	-0.012
B	1.11	432	-0.0116
C	1.13	118	-0.0134
D	1.11	91	-0.0125

- Molded at 285 °F for 108 second @ 400 psi
- Panel dimension: 12 inch by 12 inch @ 2.5 mm thickness
- Fiberglass content between 48 % and 50 %

VOC Test Method

- Sample preparation:
  - A small section was cut from a LCM panel at the center and then further cut into small chips
  - A chip was cryomilled to fine powder. A 5 mg cryomilled sample was weighted into a 22 ml headspace vial. The vial was crimp sealed for testing.
- Testing:
  - The sealed vial was heated to 70 °C for 45 min to allow volatilities to emit.
  - After equilibration, a static headspace sample was collected and injected into the capillary column for measurement.
- Static HS/GC/MS analysis was used to measure the level of styrene VOC and total VOCs of the panels. Commercial styrene standard was used as the reference for calculation.

VOC



Major VOC contributing factors

- Initial styrene
- Promotion package
- Filler and additive packages

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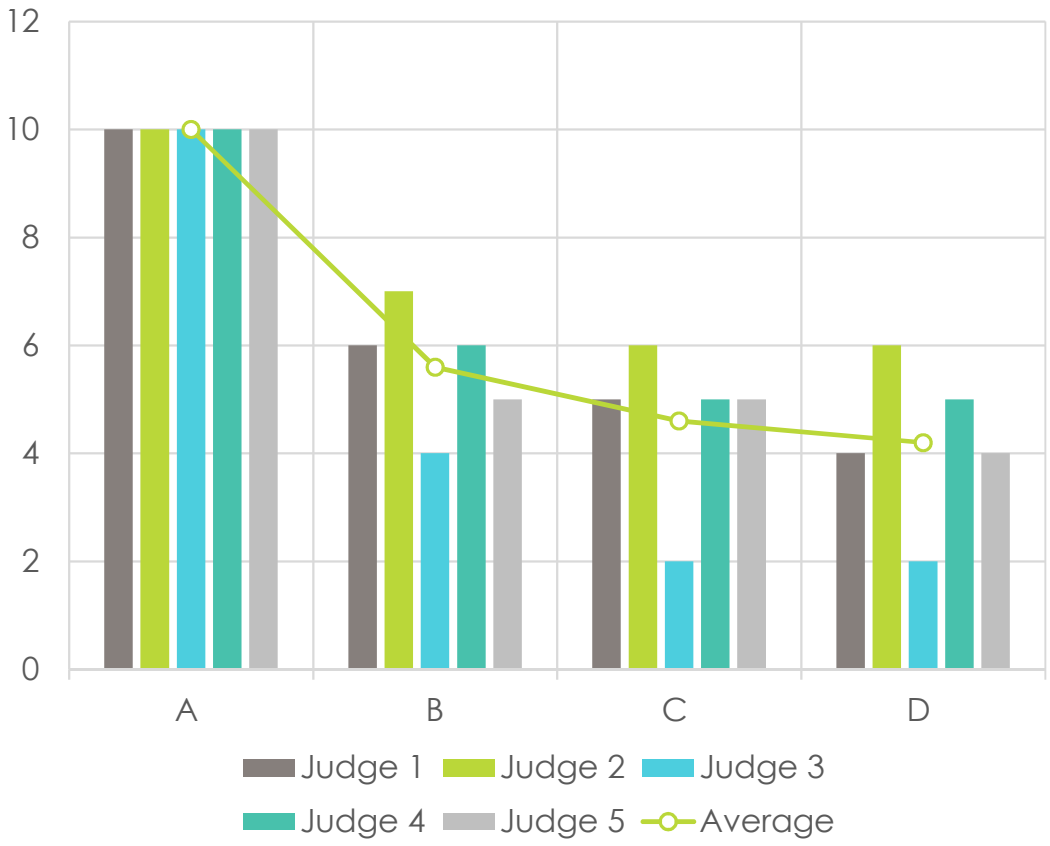
Odor



Sample preparation:

- LCM panels were cut into1in by 3 in specimen and sealed in 8 oz glass jar. Jars were heated in a 49 °C oven for 2 hr, and then equilibrated over night at room temperature.

Odor scoring:

- Judges are from different groups at Ashland technology center
- Each judge smelled a control sample and used it as a reference point with an odor scoring of 10.
- Judge smelled and assigned a value for each sample, as 0 being no odor.

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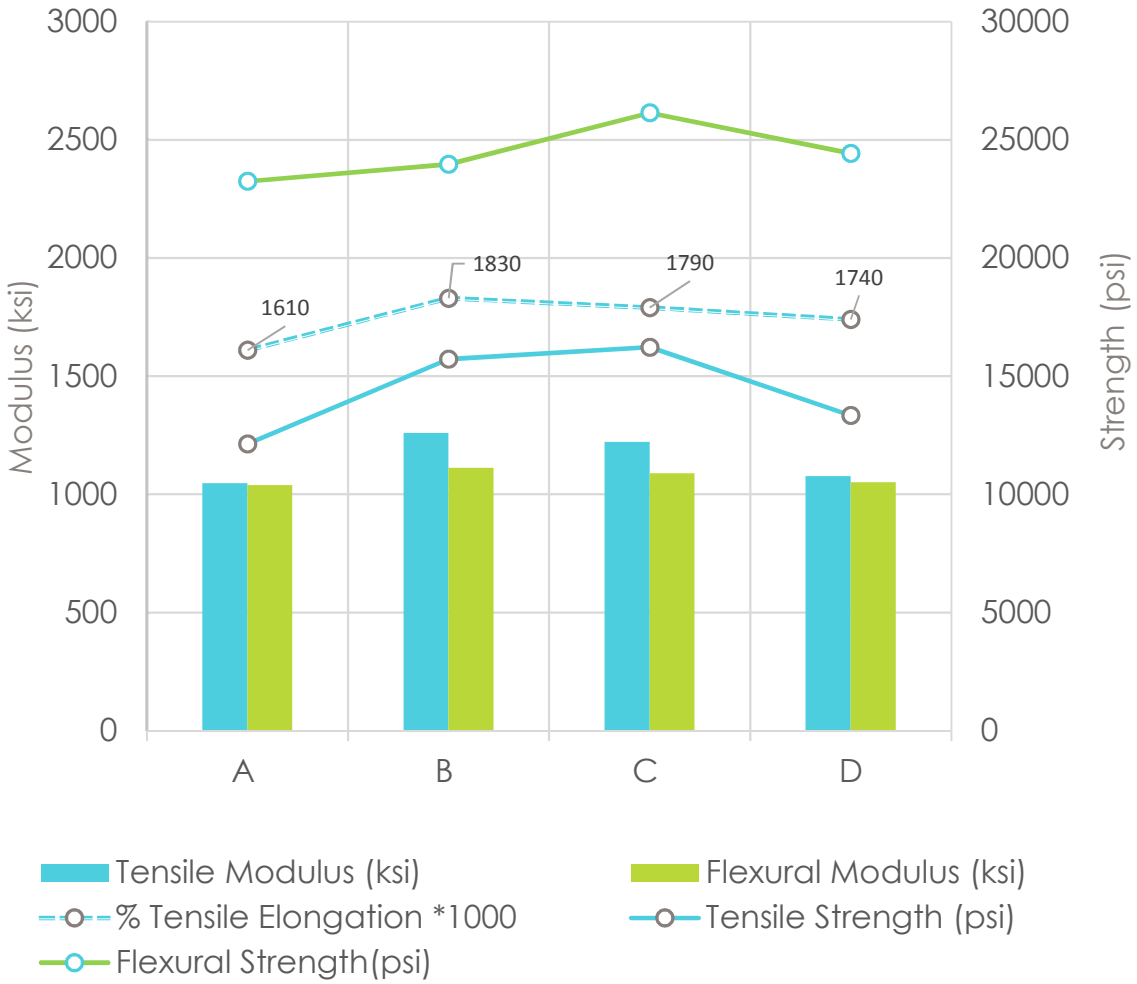
Tensile and Flexural Properties



- Equivalent or improved strength
- Equivalent or improved modulus
- Equivalent or improved elongation

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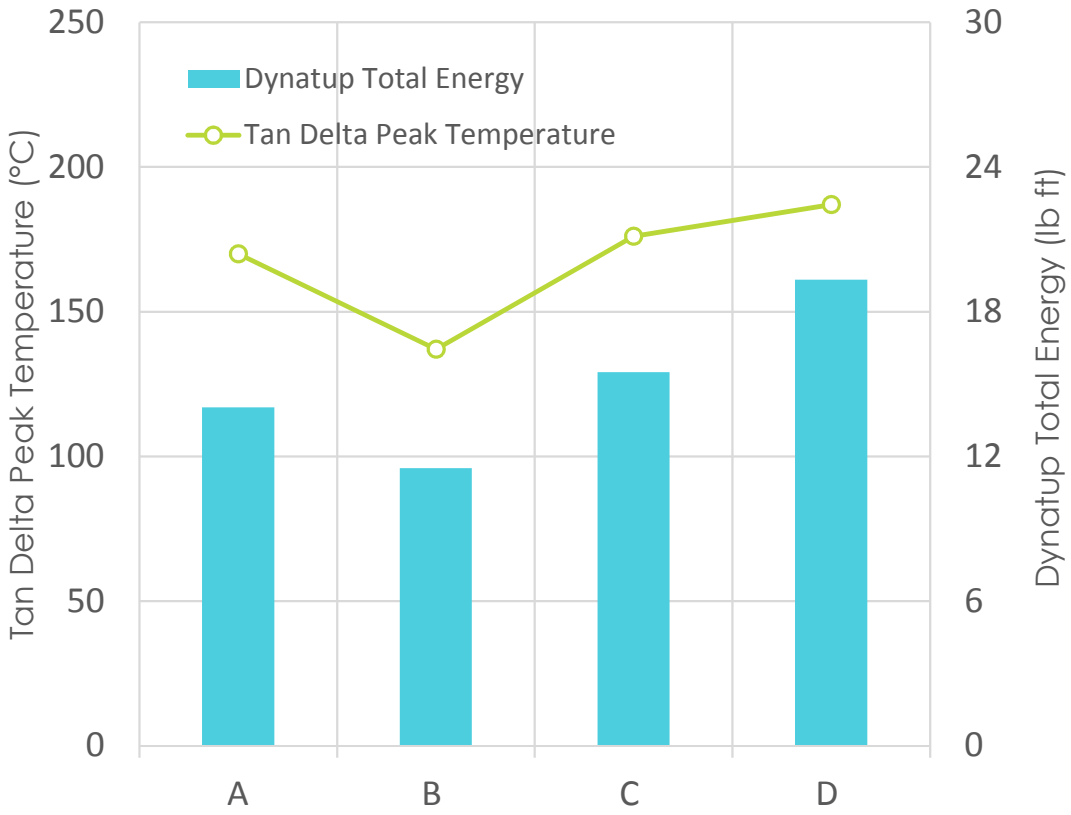
Toughness and Thermal properties



- Dynatup energy impacted by the type of the alternative diluent.
- Thermal properties impacted by the type of alternative diluents.

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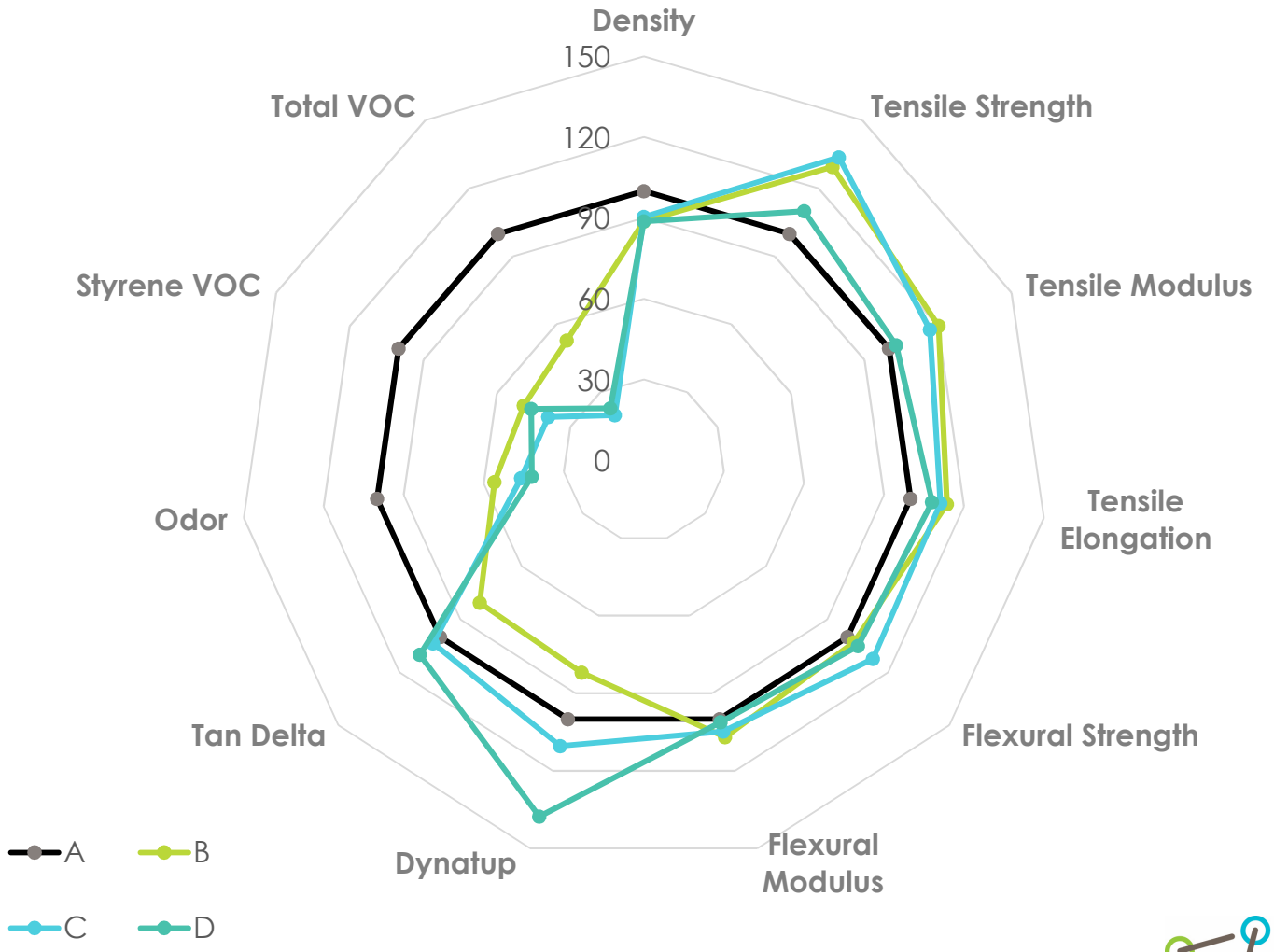
Summary



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Benefits

Parts made with low VOC low odor LCM resin technology offers

- > 50% reduction in styrene VOC, total VOC, without post baking.
- less odor.
- lower density.
- excellent thermal properties and part appearance.

The technology is

- affordable due to a low alternative diluent loading and a simplified additives package.
- a resin solution when post bake is not desired.
- a potential resin solution for other liquid molding process, such as RTM.

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Thank you !

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