

Reduction of Emission in Thermosetting Material

“Emission Reduction in SMC”

Frank Lauterwasser / 28.11.2006

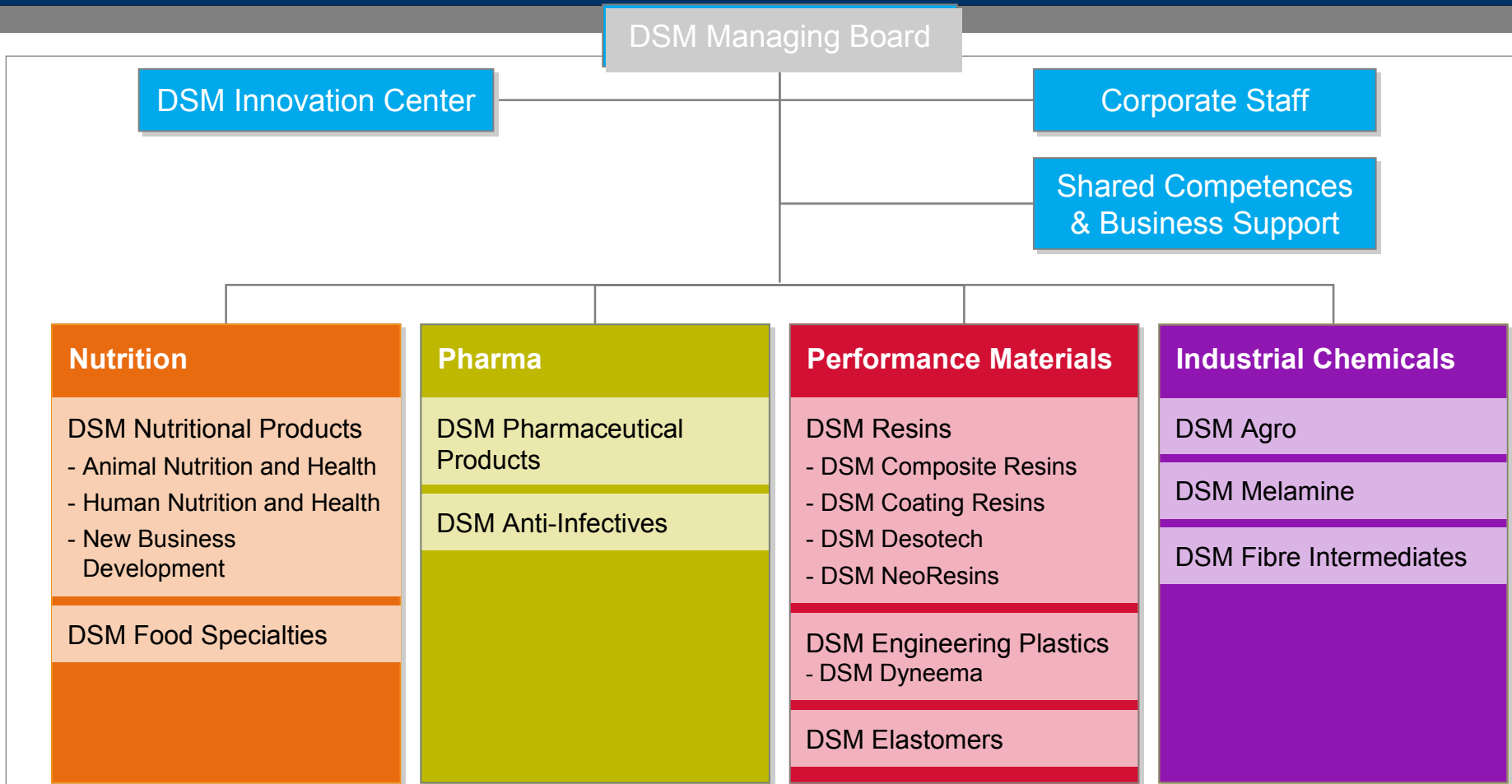
DSM Composite Resins GmbH

Ludwigshafen

Outline

- About DSM
- Sheet Moulding Compounds (SMC)
- SMC and Emission
 - I: Requirements & Targets
 - II: Challenges
- What are the Emissions/Source of Emissions
- Routes to Solve the Challenge
- Palapreg G-20-01-X LE: Solution at the Market
- Achievements
- Outlook

The DSM Organization



The number one of the chemical industry in the Dow Jones Sustainability Index

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Many Divers Applications

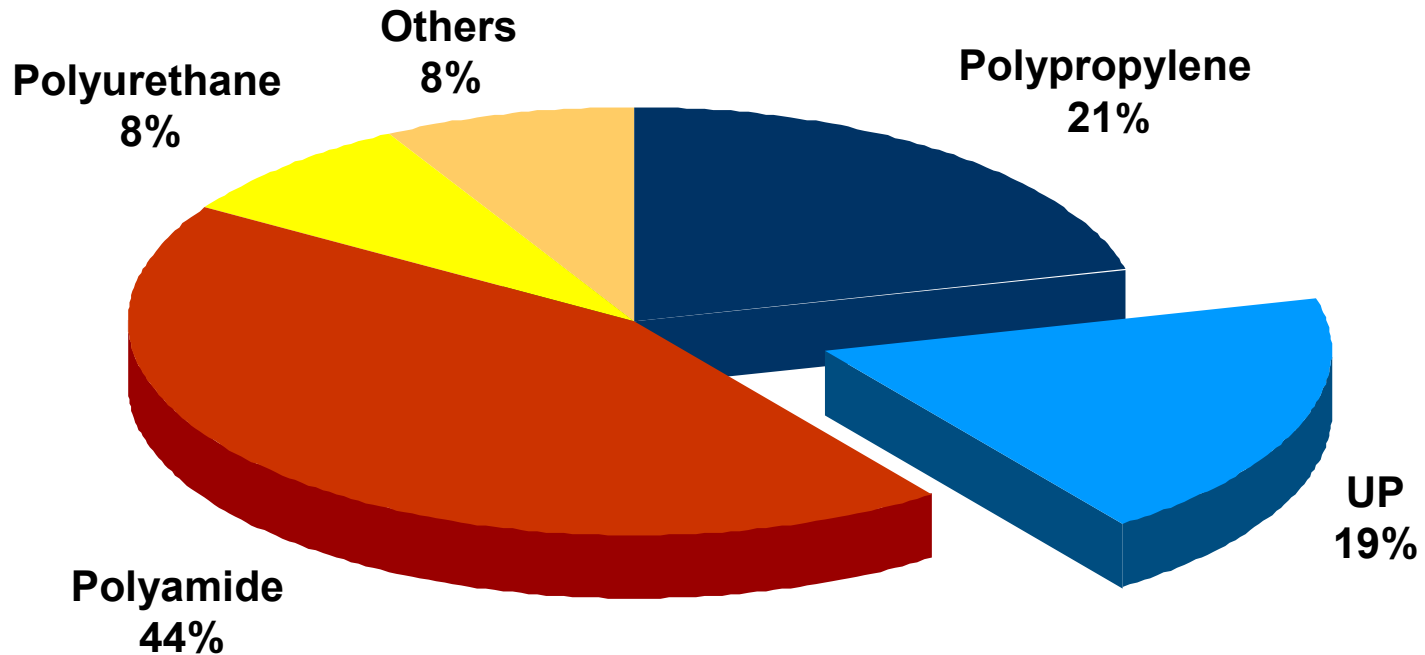


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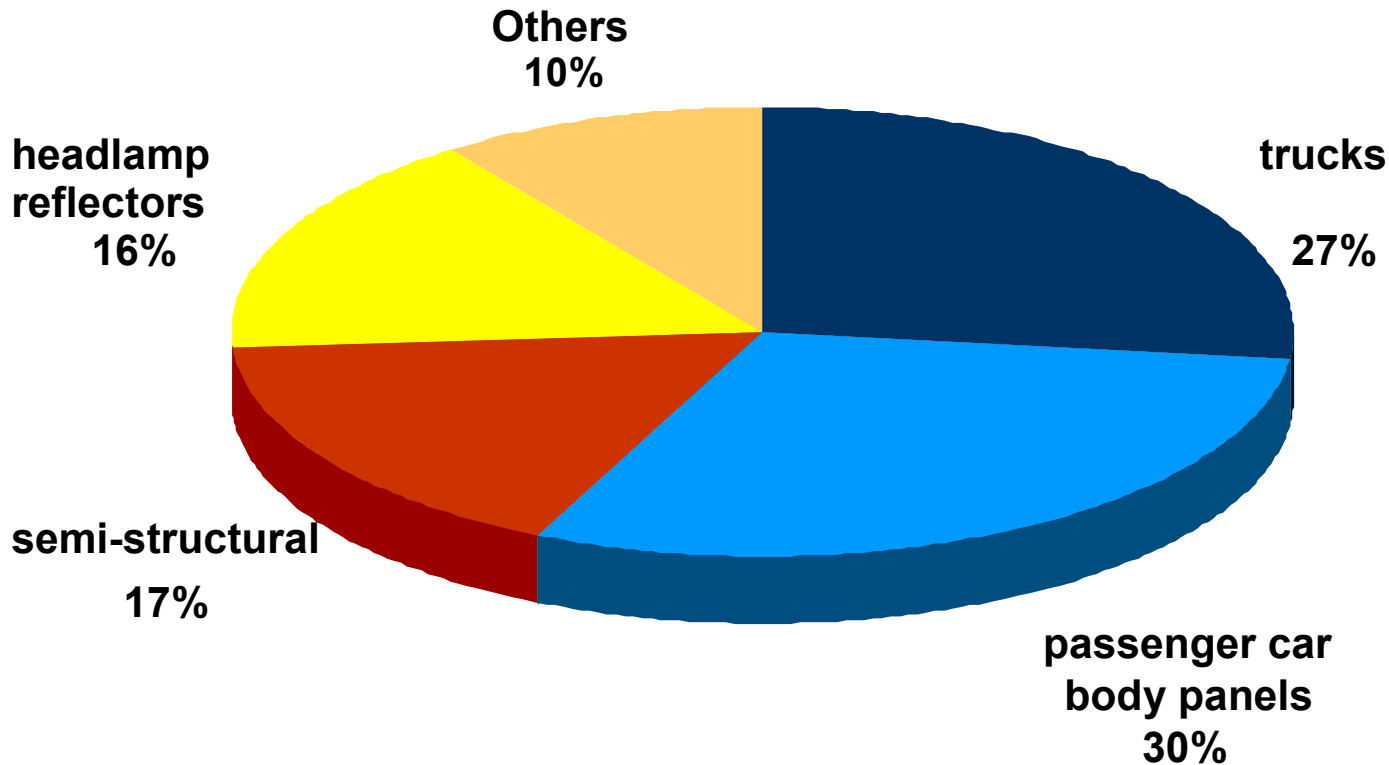
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Material (Resin) Diversity in Automotive



Unsaturated polyester resins (UP) account for approximately 19% of the resin market for composites in automotive

Main UPR Automotive Applications (WE)



Trucks and passenger car body panels are the main application areas for UP composites in automotive with a share of 27 and 30% respectively.

Application

Car Parts



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Application

Truck Parts



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SMC = Sheet Moulding Compound



Components:

- **UP Resin**..... **60 T**
- Low Profile Additive..... 40 T
- Filler 200 T
- Thickening (MgO)..... 2,5 T
- Peroxide..... 1,5 T
- Zinc stearate..... 4,0 T
- Glass fiber 28%

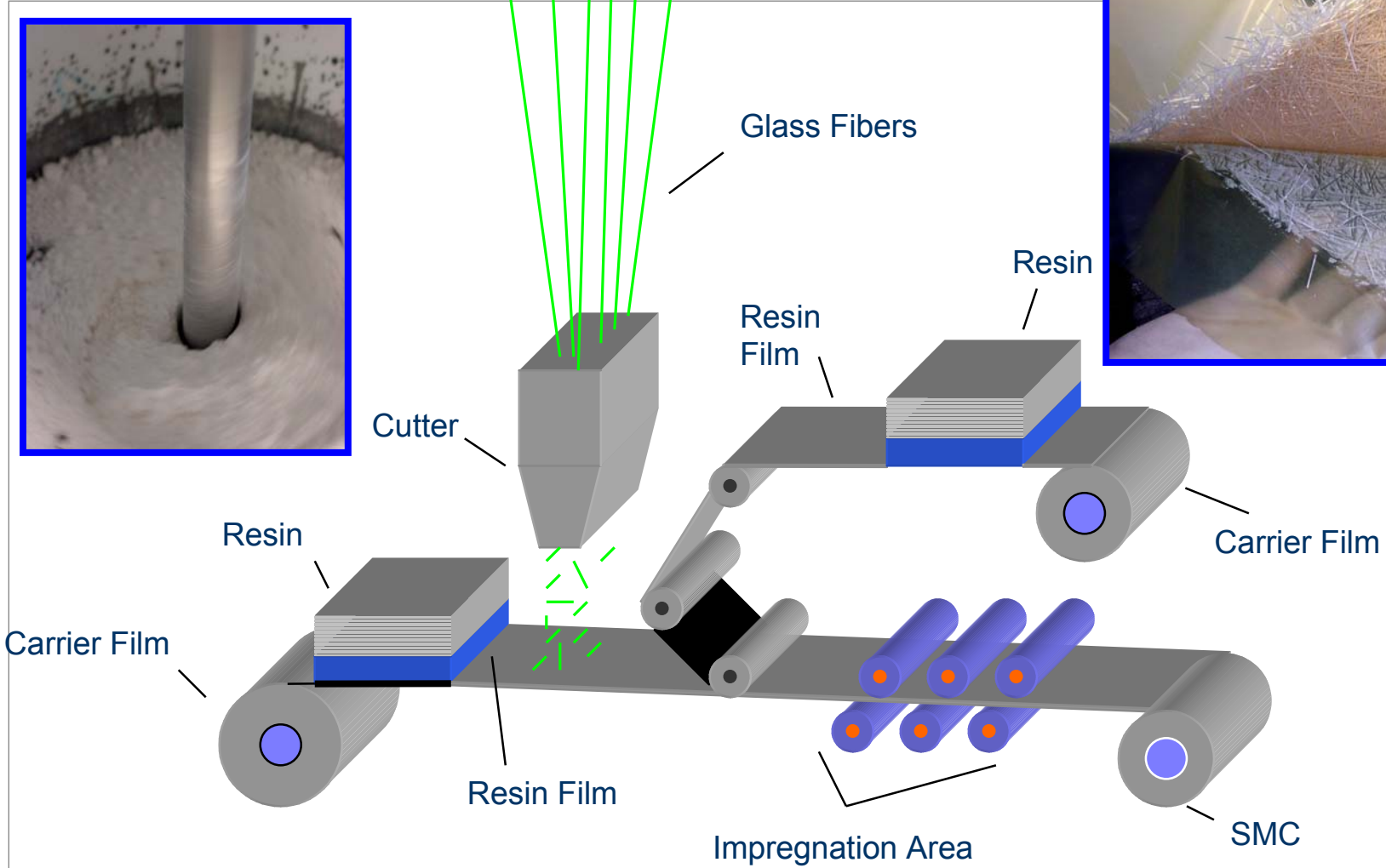
- Weight saving
- Part consolidation
- Design freedom
- Lower level of investment
- Opportunity to integrate antenna system
- E-coat compatibility
- Class-A surface finish
- Dimensional stability

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SMC Manufacture



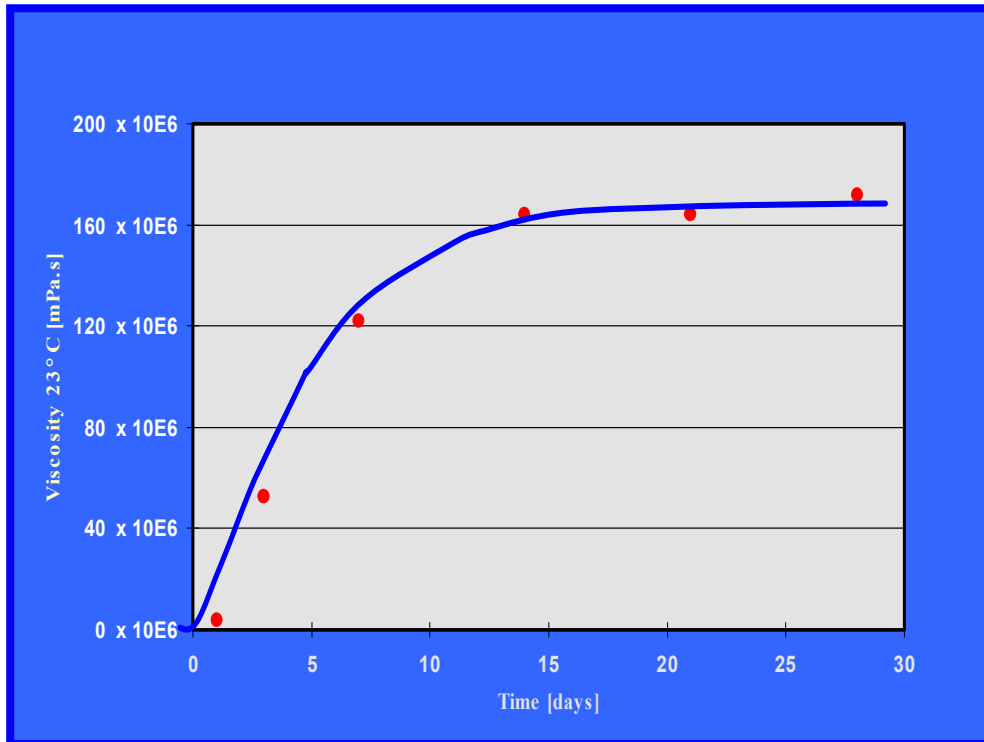
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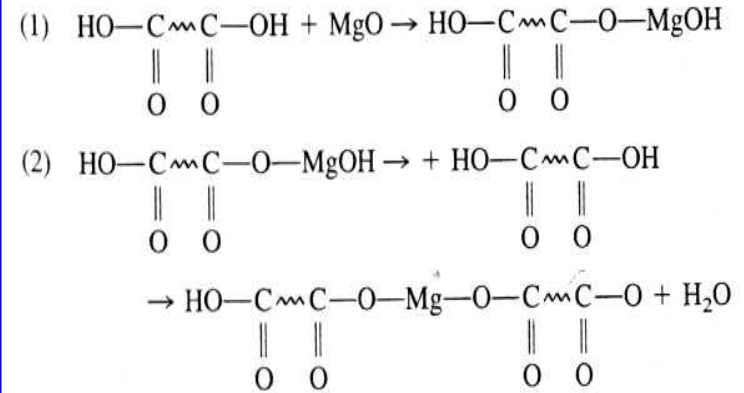
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SMC Thickening

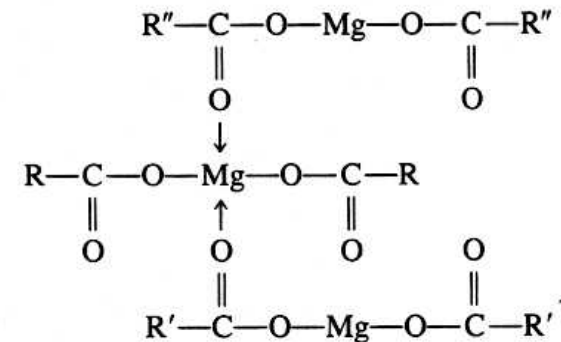
Thickening:



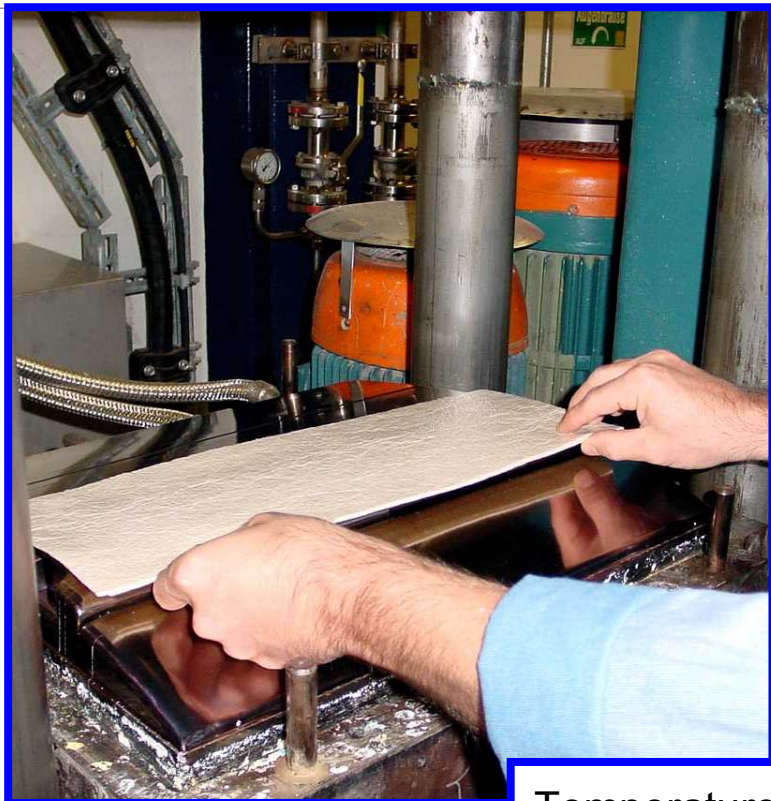
SMC paste viscosity increase over time.



✓ *Thickener (MgO).....2,5 T*



SMC Molding



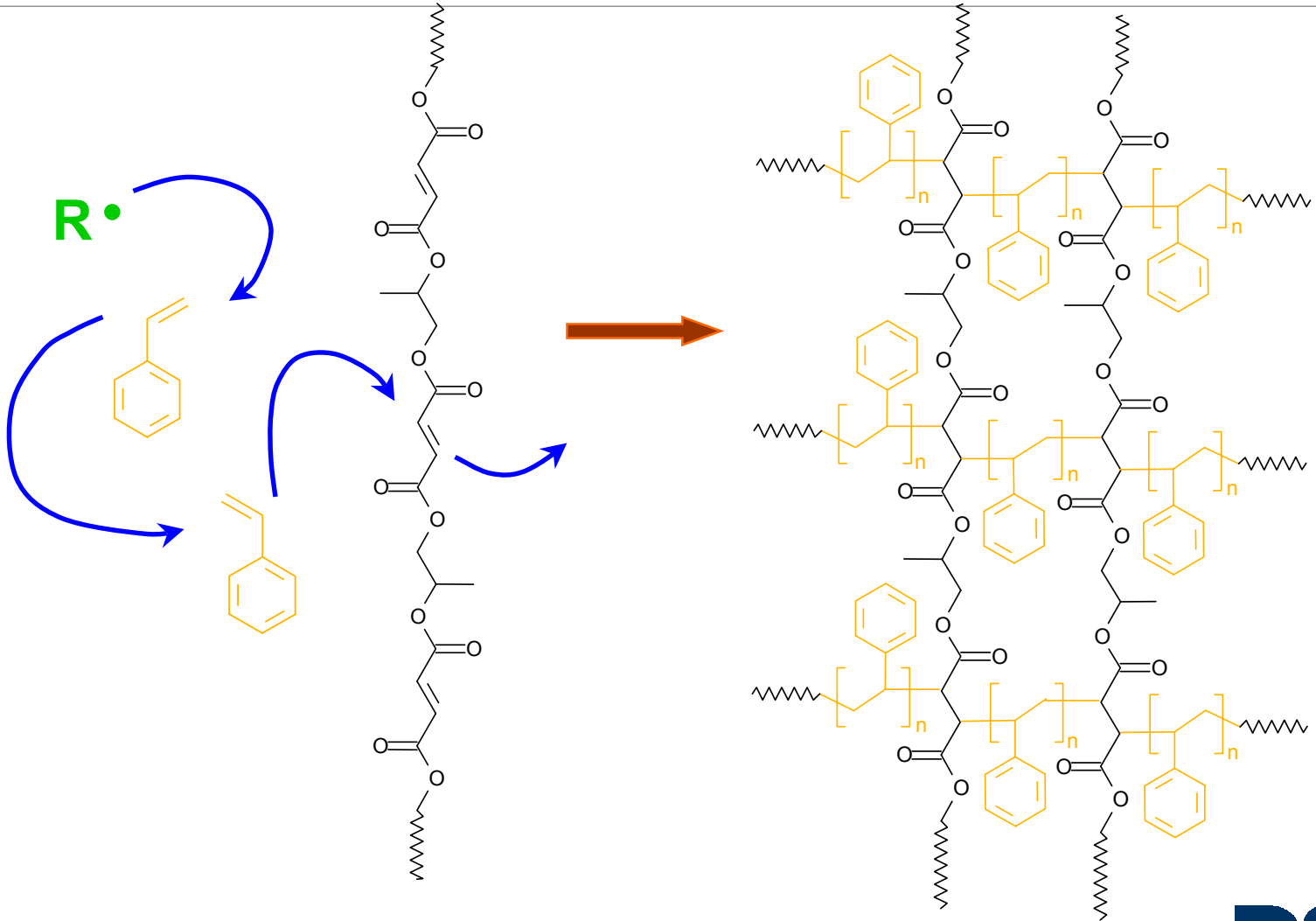
Temperature.....140 – 160 °C
Pressure.....60 - 100 bar
Time.....2 – 3 min.

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SMC Curing



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SMC and Emission I: Requirements

Material for Automotive:

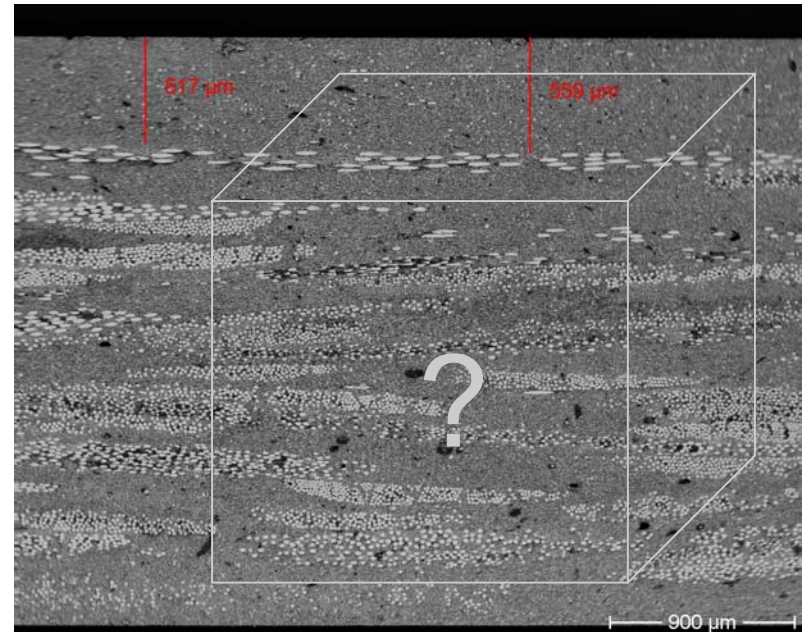
- No toxic / aromatic compounds (benzene)
- Reduction of CARB value
- Reduction of VOC emissions by (e.g. for TD <100 ppm)
- Excellent surface quality (Class A)
- Good mechanical properties
- Total value of volatile organic material (VOC) has been significantly reduced over last years, but not yet reached target.

SMC and Emission II: Challenge

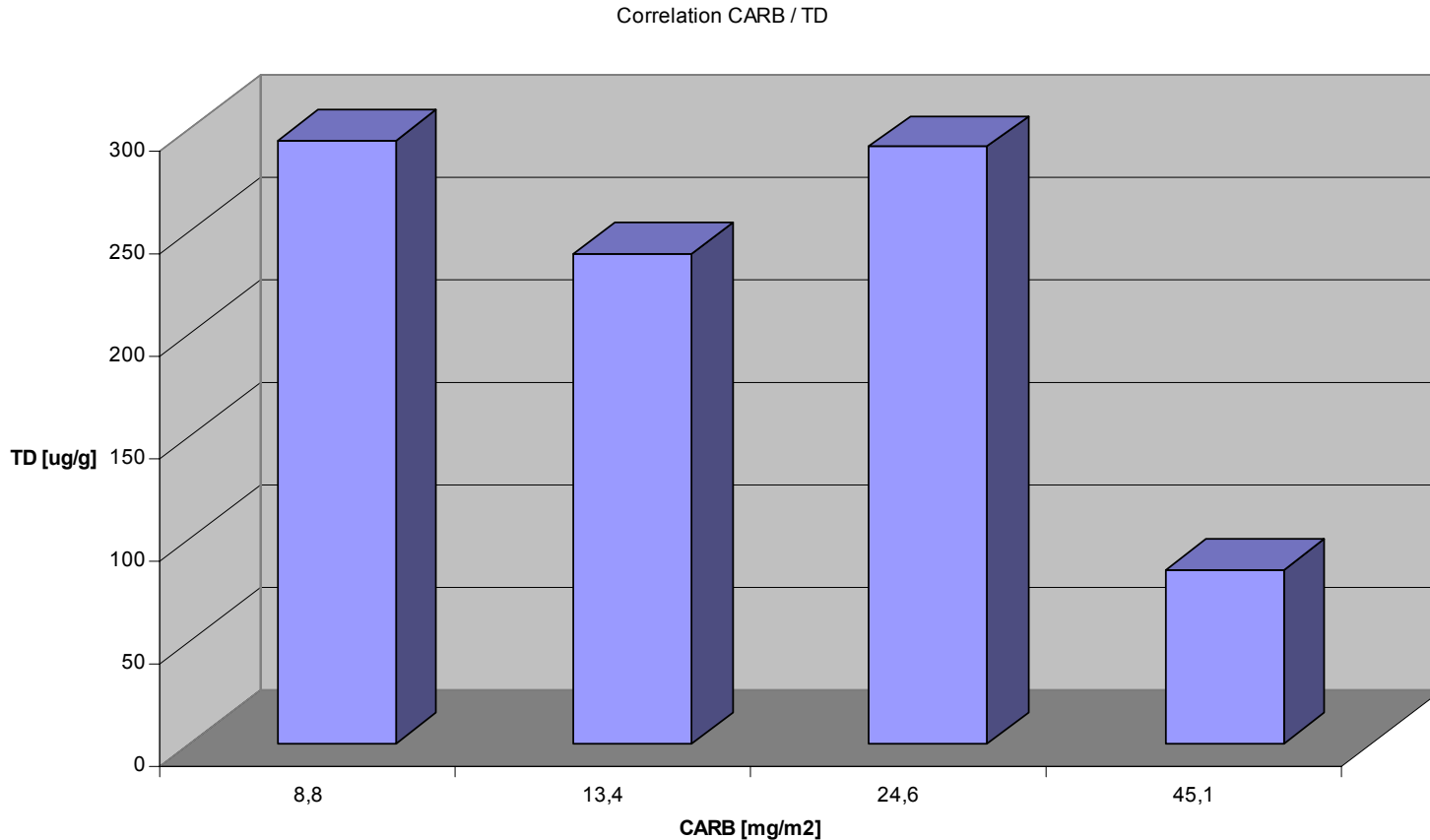
- **Different analytic methods:**
 - **Headspace (HS):** Samples are heated in defined test chambers. From saturated atmosphere gas samples are taken and analyzed via GC-MS. Cut out a part of 3 g, 120°C for 5 h (!!! Cut edges!!!)
 - **California's Air Resources Board (CARB):** Testing of complete parts 18 - 40°C over 24 h.
 - **Thermodesorption (TD):** Sample is heated (90°C) , a gas-flow desorbs the emitting material that then is trapped at low Temperature. Analysis via GC-MS. 10-50 mg per samples. (!!!grinded!!!).
 - Correlation is difficult (Inhomogeneous Material)

SMC and Emission II: Challenge

- Reproducibility and correlation is difficult (Inhomogeneous Material)
 - SMC is a composite material from polymer, filler and glass fiber.
 - Density is 1,9 gr/cm³.
=> 30 mg volume of 16 mm³
 - 16 mm³ => 2,5 mm per side.
 - How much filler and glass contains this cube (homogenous) ??



Correlation of Different Methods



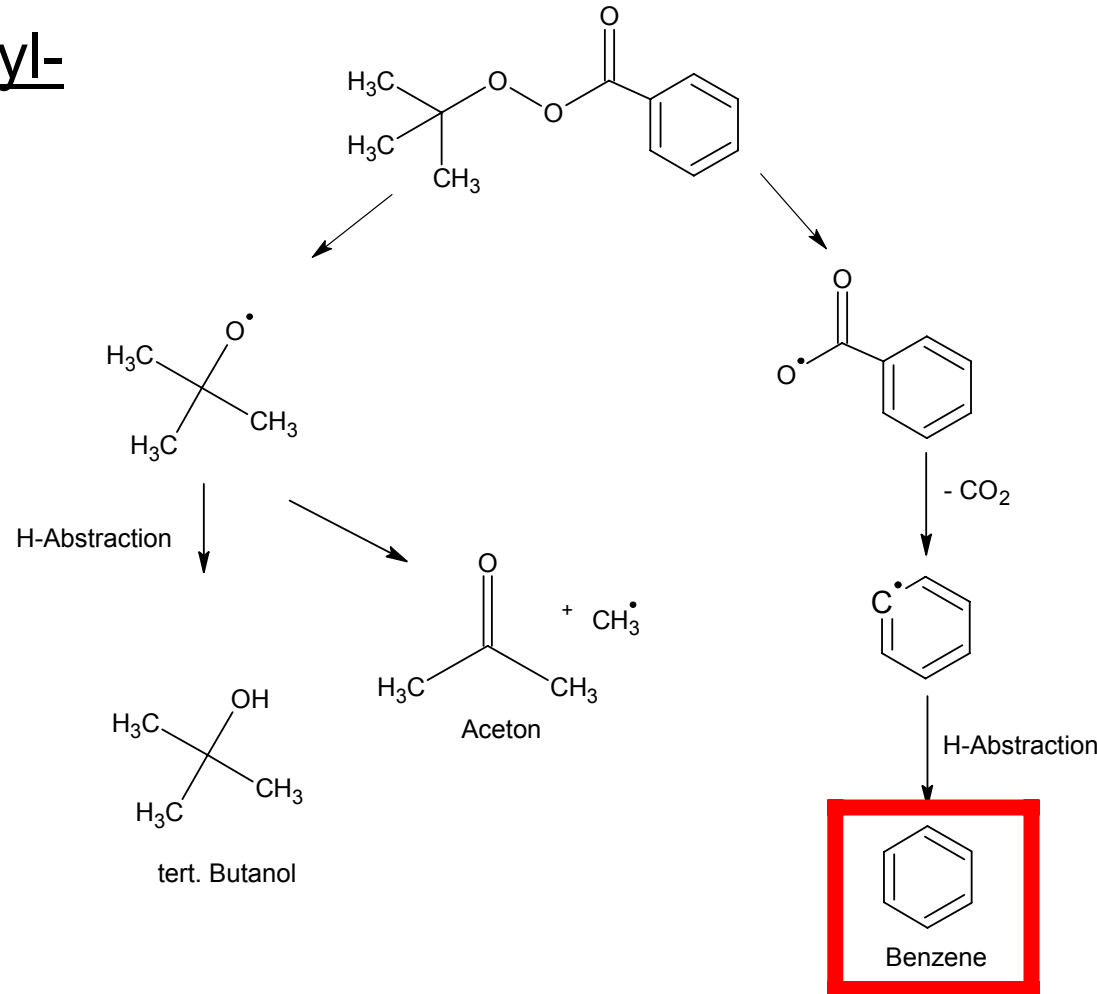
TD = Thermodesorption; **CARB** = California's Air Resources Board

What are the Emissions / Where they from

Emissions: Initiator = t-Butylperoxybenzoate:

- Acetone 10-20%
- t-Butanol 40-50%
- Benzene 5-10%
- Styrene 5-10%

- Rest < 5%



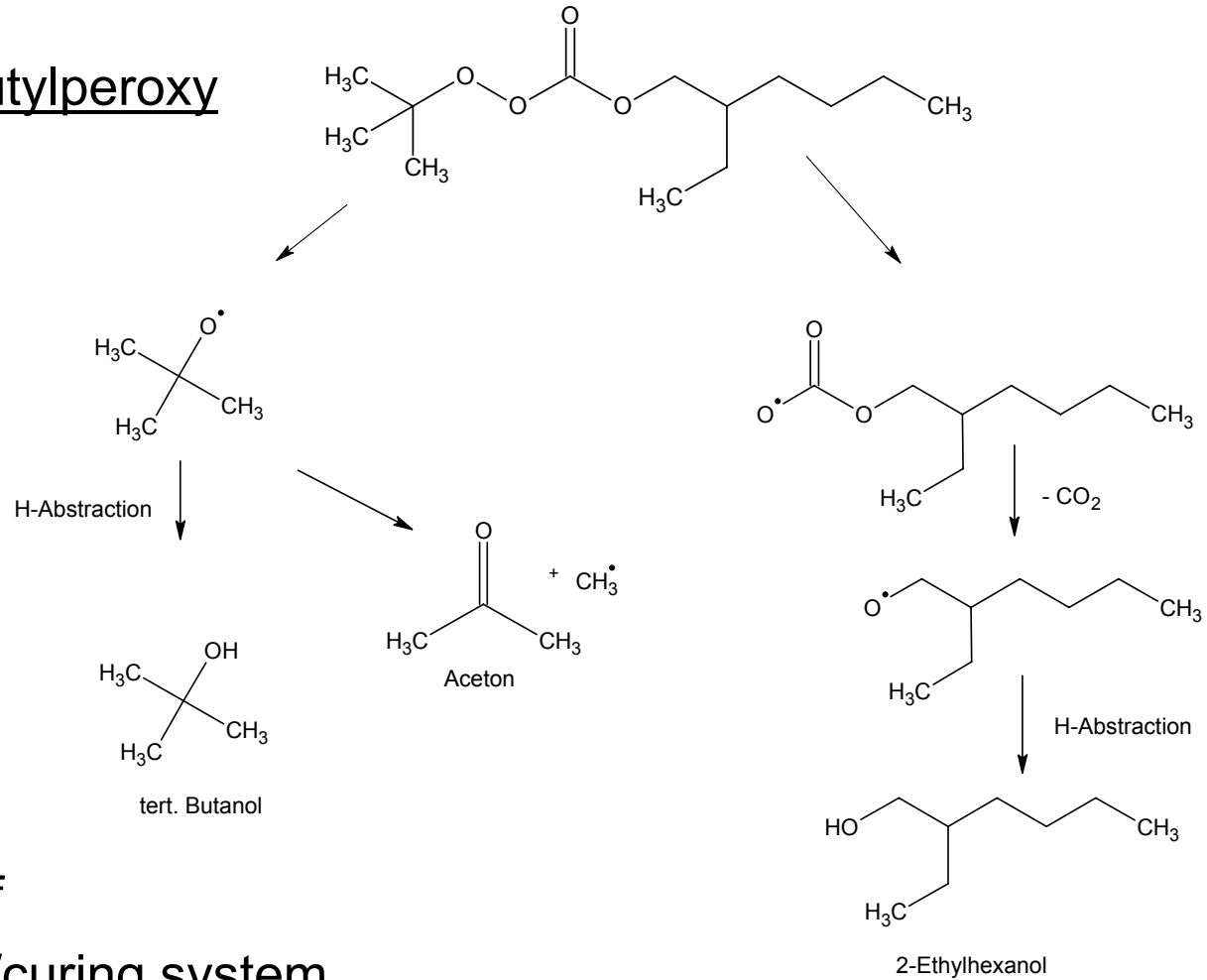
What are the Emissions / Where they from

Emissions: (Initiator = t-Butylperoxy-2-ethylhexyl-carbonate):

- Acetone ~ 14%
- t-Butanol ~ 10%
- 2-Ethylhexanol ~ 50%
- hexanol
- Styrene < 1 ppm
- Rest ~ 25%

- VOC: 400ppm (2003)

- Known that 65 - 75% of emission from peroxide/curing system



Possible Routes to Reduce Emission in SMC

How to reduce emission of SMC parts???

Compound
(No Emission)

Process
(Coating)

- Initiator
- Optimization of formulation:
- Resin Technology

- External Barrier
- Post-Treatment

Low emission SMC part

Palapreg G-20-01-X LE: Solution at the Market

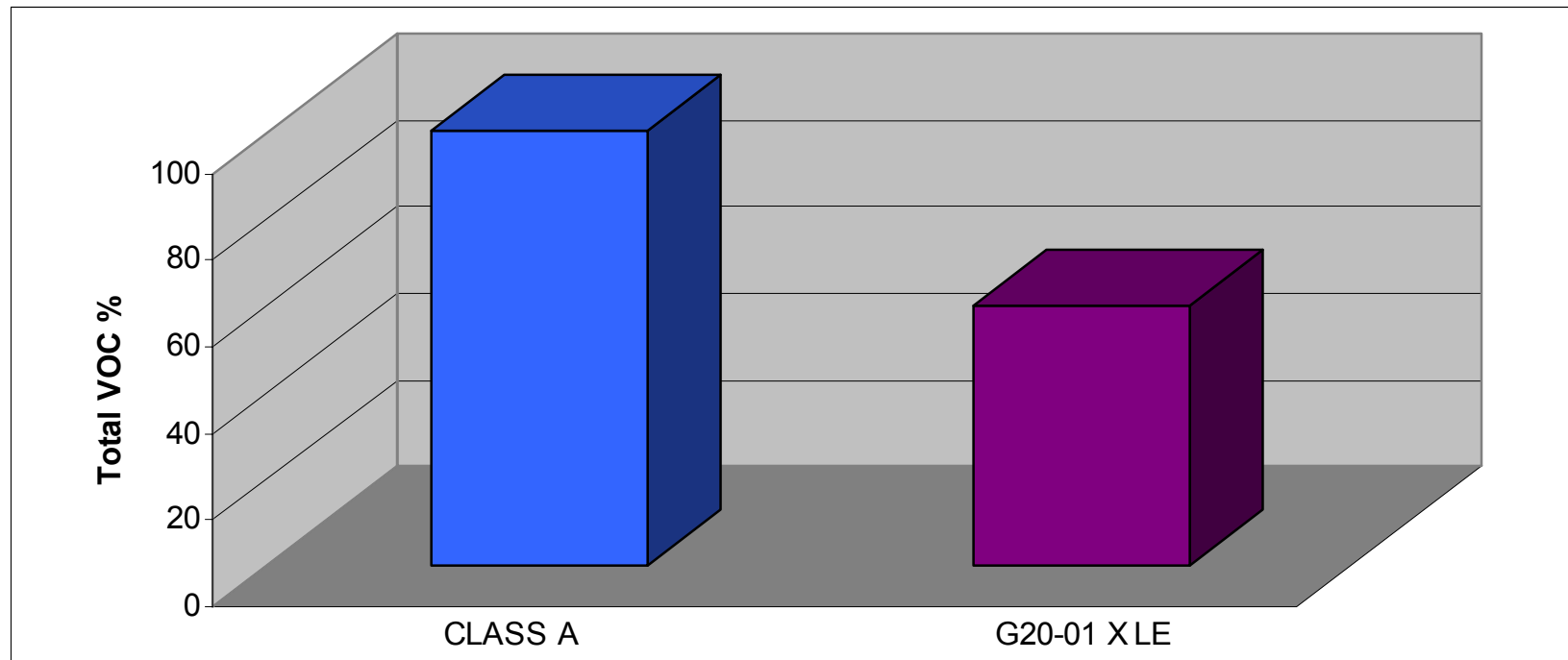
DSM Class A Low Emission System

DSM offers a complete package for maximum emission reduction and easy handling:

- 1-component Class A system
 - Reduce emissions coming from peroxide
 - Critical solvents eliminated
 - Zero styrene in emissions
- Recommendations for
 - SMC formulation
 - Curing system
 - Moulding parameters 148 / 155°C @ 2 min

Emission Reduction System

VOC comparison: State-of-the-art Class A system vs. Palapreg G20-01-X LE



- Reduction of VOC in respect of different analysis methods is between 30 - 50%

Achievements

- Carcinogenetic materials are eliminated.
- Monomeric styrene is reduced under 1 ppm.
- Introduced Palapreg G-20-01-X LE as a new low emission SMC formulation with reduction of total VOC between 30 to 50% compare to a state-of-the-art SMC.
- Reduced smell.

Achievements & Targets

- Carcinogenetic materials are eliminated.
- Monomeric styrene is reduced under 1 ppm.
- Introduced Palapreg G-20-01-X LE as a new low emission SMC formulation with reduction of total VOC about 30 to 50% compare to a state-of-the-art SMC.
- Reduced smell.
- Emission < 100 ppm (TD) with excellent surface and mechanical properties.
- Further smell reduction.

Outlook

- Further achievements only with good cooperation between the participating parties
- Standard analytical method for emission screening.
- Matching of the total VOC value by the OEMs to the state-of-art analysis technology.
- Samples should represent real parts (no 30 mg samples).