Engine Expo North America 2012

Liquid Gaskets to Enable Light-weight Initiatives in Powertrain Development

Matthew Boback

Henkel Corporation

Henkel Excellence is our Passion

Contents

Henkel Corporation

Henkel worldwide

- Brands and technologies in worldwide
- About 47,000 employees

Fiscal 2011

Sales:	15,605 mill. euros
Adjusted[1] operating profit (EBIT):	2,029 mill. euros
Adjusted[1] return on sales (EBIT):	13.0 %

Three areas of competence

Laundry & Home Care

Cosmetics/Toiletries

Adhesive Technologies

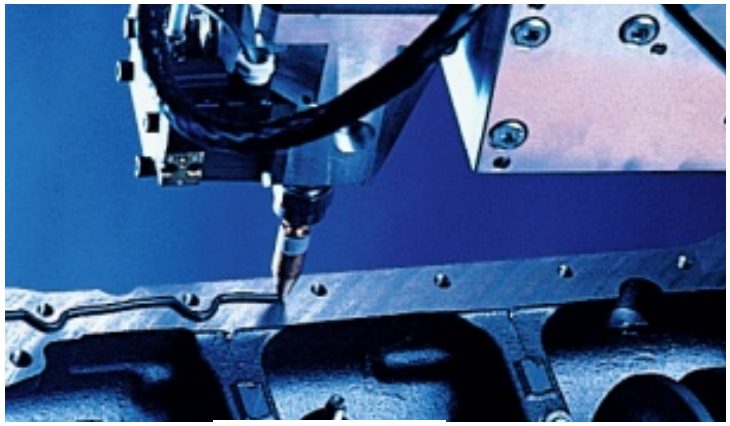
Top brands

Purex, Soft Scrub, COMBAT, RIGHT GUARD, Dial, SOFT & DRI, LOCTITE, Teroson, technomelt

[1] Adjusted for one-time charges/gains and restructuring charges.

Liquid Formed-in-Place-Gasketing (FIPG)

A core Henkel competence



VS.

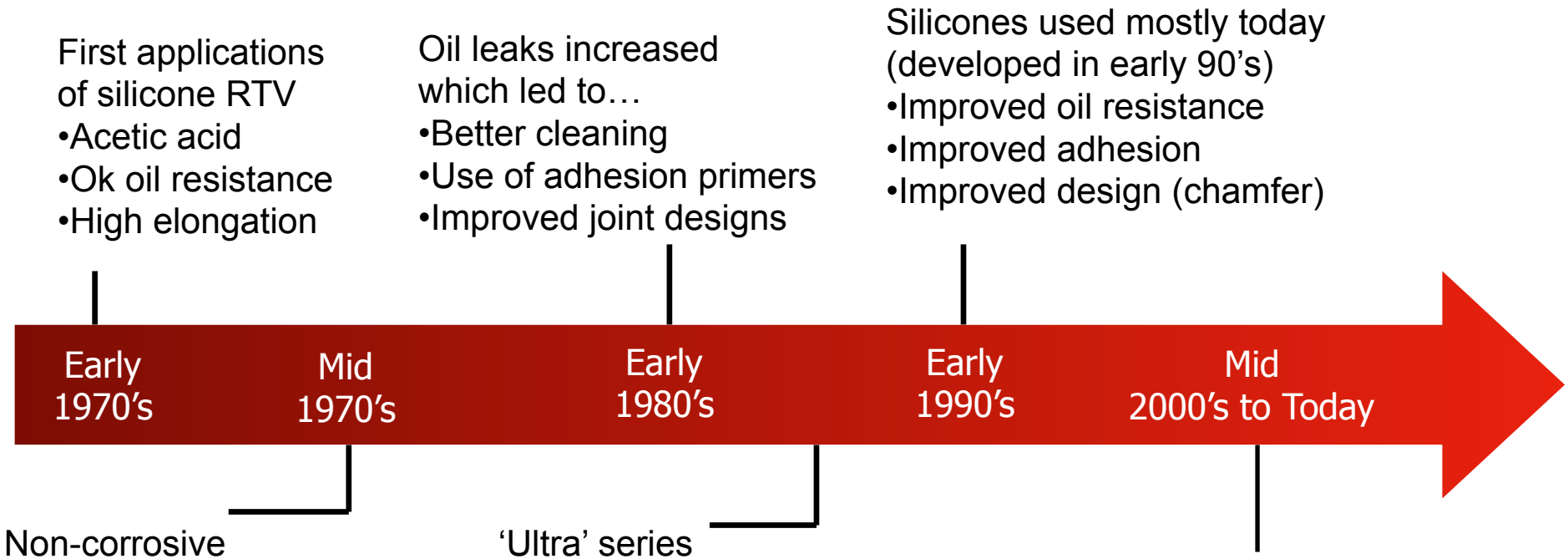
Loctite Brand liquid gasketing products are **low cost, high quality** sealing solutions/alternatives to traditional molded and cut gaskets used to seal automotive parts.

"Liquid gaskets are the lowest cost sealing solution."

OEM Materials Engineer at a Powertrain Conference

Formed-in-Place Gasket (FIPG)

Development History in NA

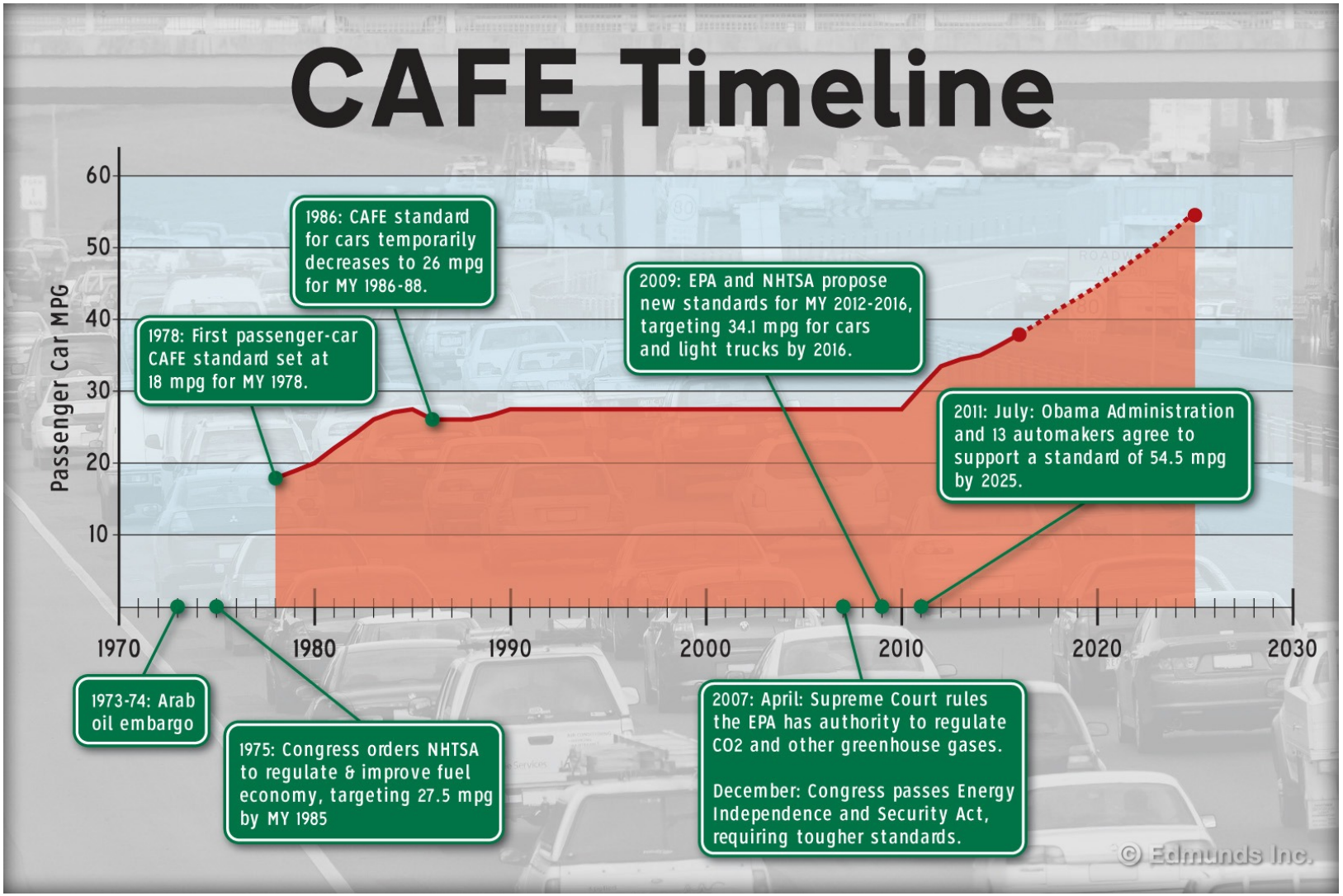


Background

As vehicles move to reduce the overall weight in an effort to improve fuel economy and reduce overall costs, plastic components are being introduced to replace traditional metal substrates. With improved adhesion properties of liquid formed-in-place gasket sealants, plastic oil pans can now be sealed with methods long used on metal substrates. This process reduces the overall weight and cost of the engine, giving manufacturers increased flexibility in design.

Market Demands

CAFE Requirements



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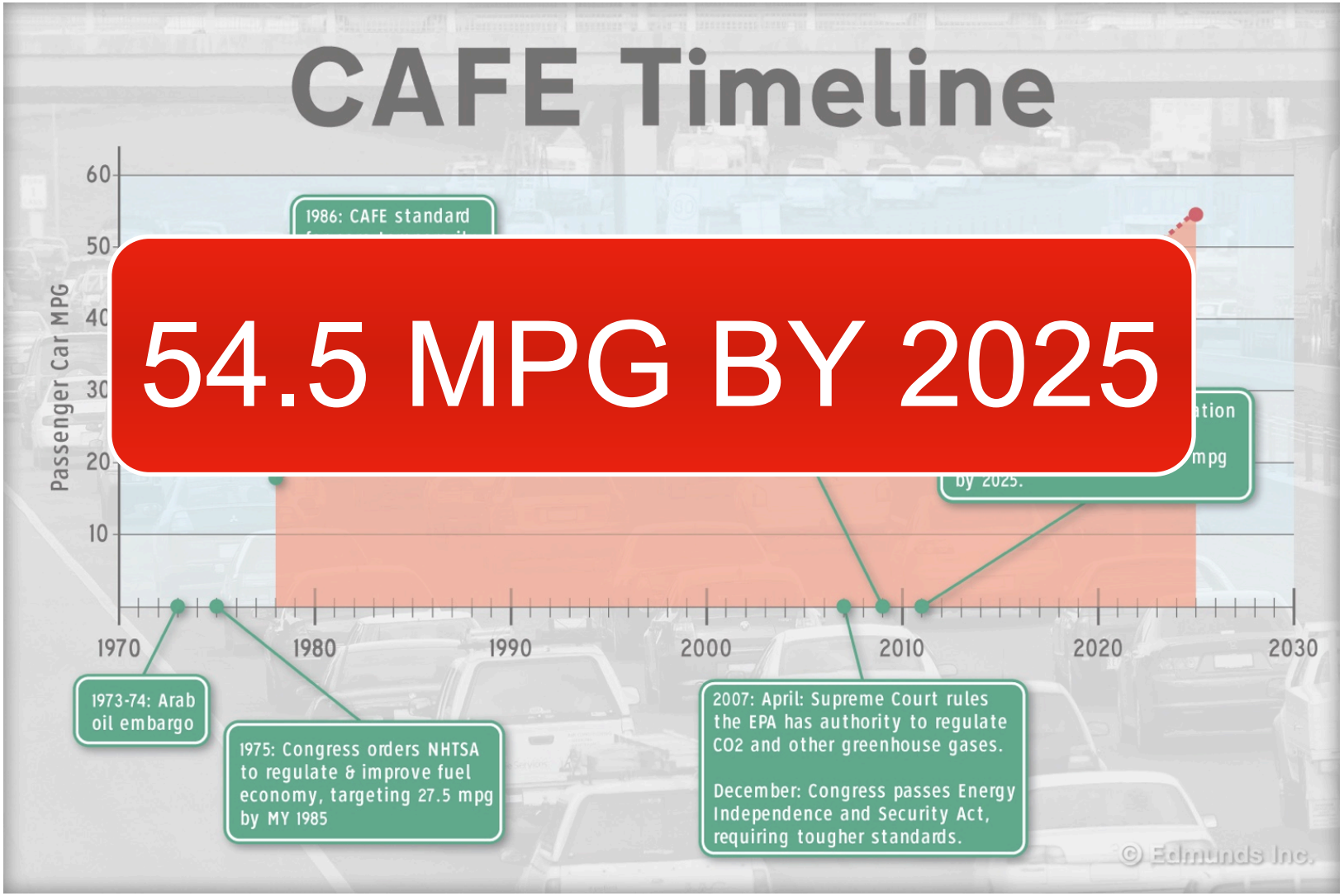
Market Demands

CAFE Requirements



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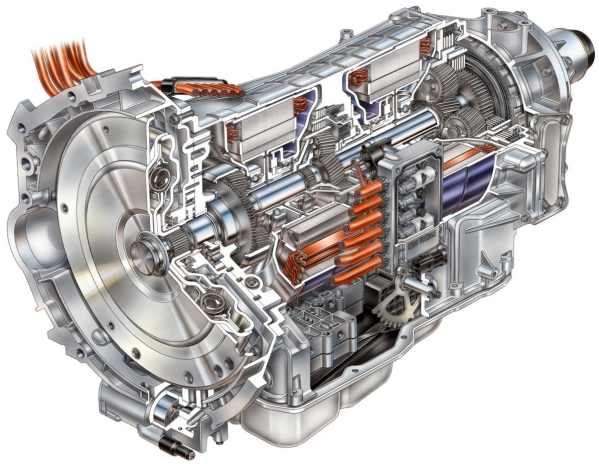
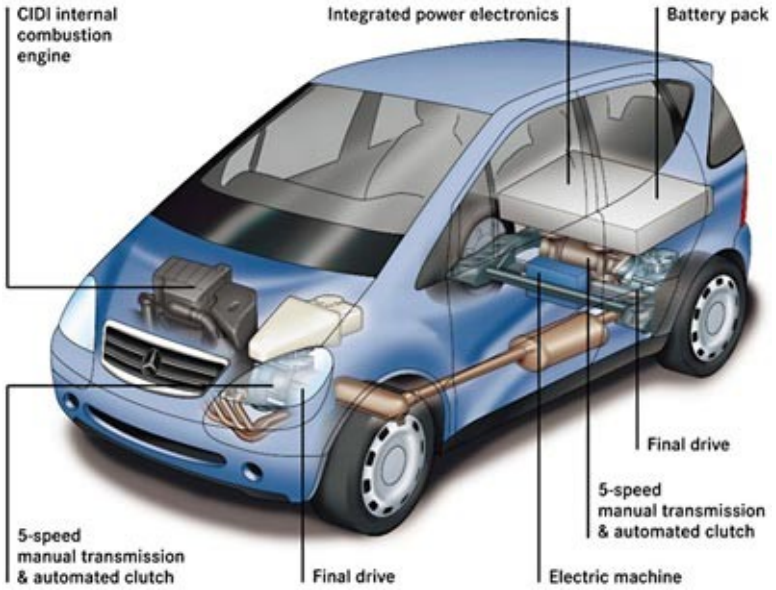
Market Demands

Improved MPG

- Alternative Power Sources
- Smaller Engines (addition of turbo/super chargers)
- Improved Transmissions
- Light Weighting Initiatives



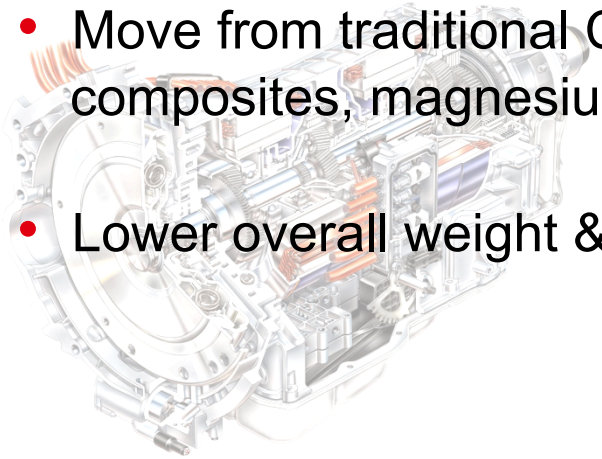


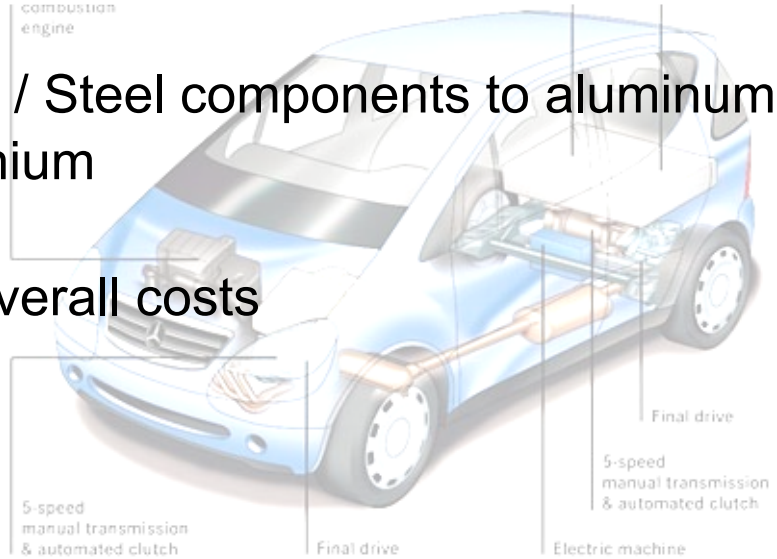
Market Demands

Improved MPG

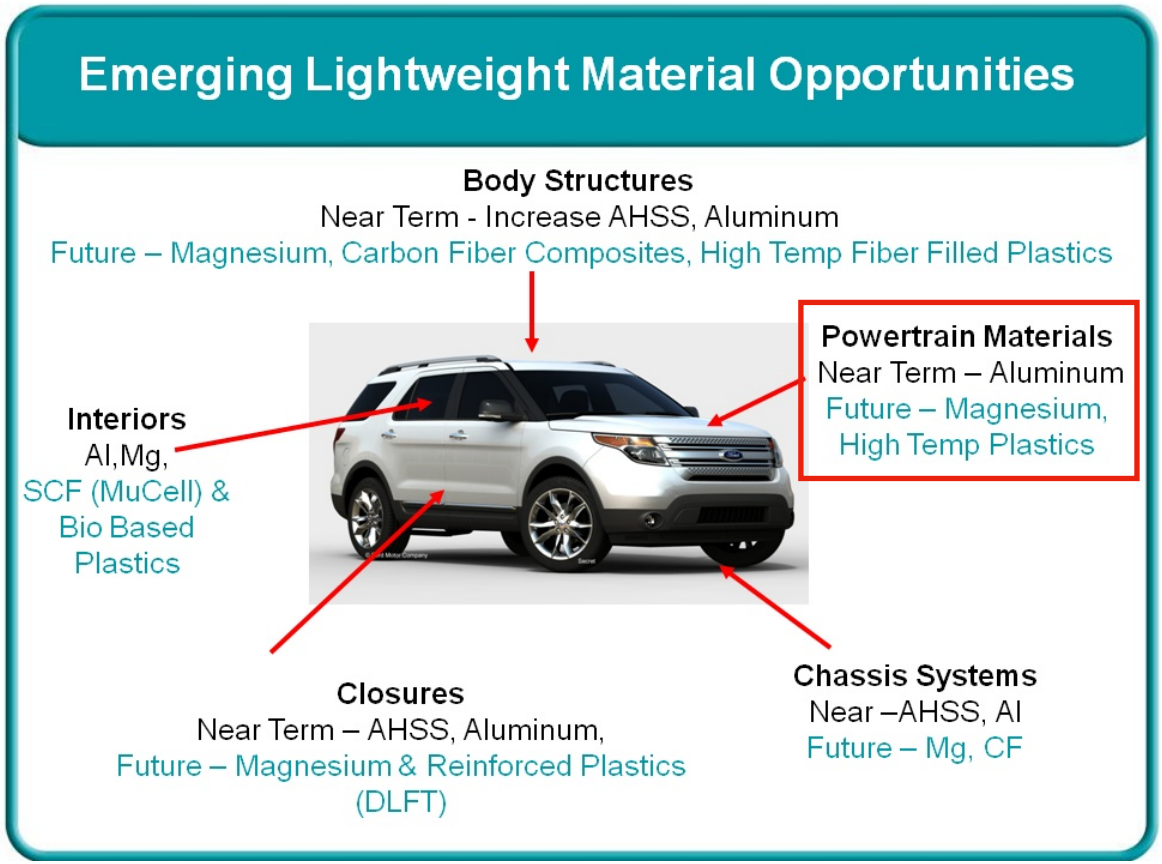
- Alternative Power Sources
- Smaller Engines (addition of turbo/super chargers)
- Improved Transmissions

- Light Weighting Initiatives
  - Move from traditional Cast Iron / Steel components to aluminum, composites, magnesium & titanium
  - Lower overall weight & lower overall costs





Market Demands
Light-weighting



Source: SAE Webcast, Nov. 2010 – Automotive Weight Savings and Cost Reductions
Ford Motor Co.

Source: Composites Technology

- Liquid Gaskets must…
  - Adhere well to plastic & metal substrates
  - Have high elongation / oil resistance balance

Market Demands

Light-weighting Composites

Market is already integrating composite materials into traditional metal substrates for the following benefits:

- **Reduced weight (up to 50% reduction)**
- **Simpler Process**
  - Reduction of multi-piece assemblies
  - Design flexibility for integration of complex geometries
  - Multiple Cavity Molds (higher through put)
- **Lower Overall Cost**
- **Noise Reduction**

Daimler 2004 MY Actros BR500 Class B

Ultramid A3HG7 Plastic Oil pan
50% Weigh Reduction from Aluminun
1dB overall noise reduction

- Published by Composite World on 4/1/2011

Moving from concept to production…

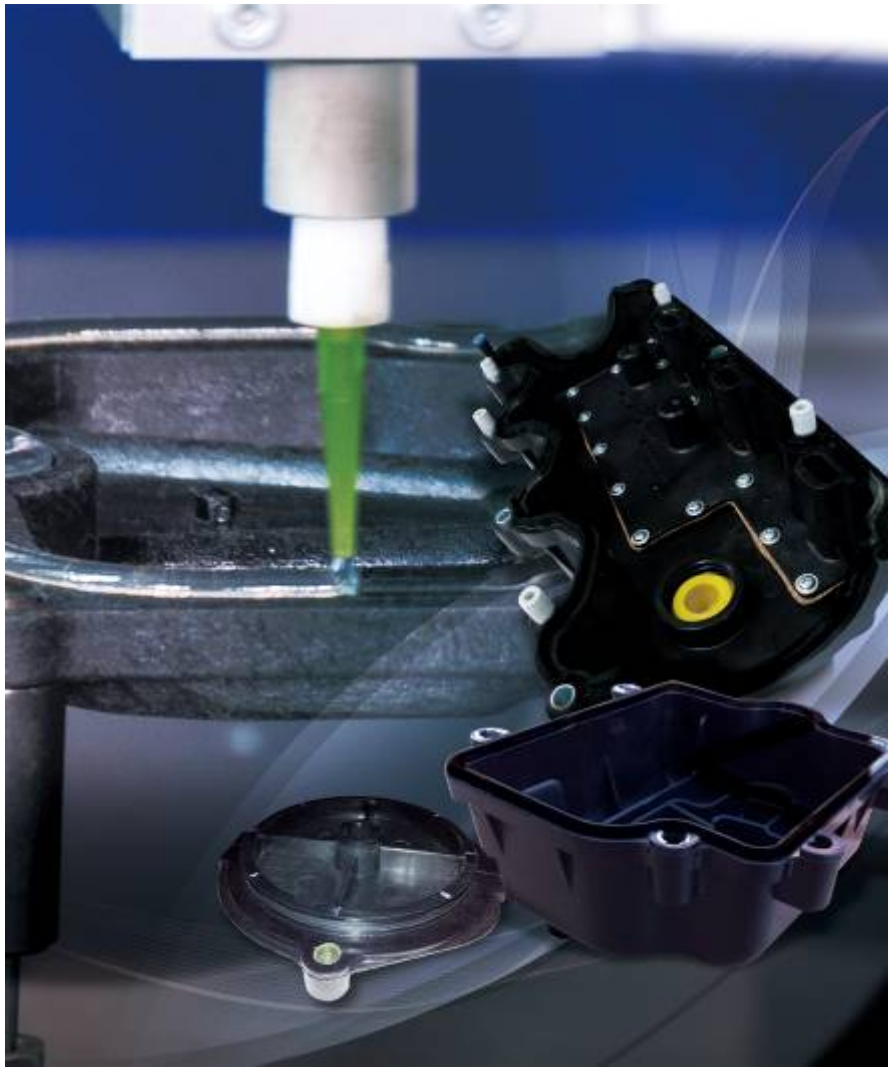
INPRO Innovation Society

INPRO Innovation Society
- Founded in 1983 to develop advanced production systems in the automotive industry
- Joint venture - BASF, Siemens, ThyssenKrupp, Daimler, Volkswagen and the state of Berlin
- € 7 million revenue

- **Project Objective:**
  - To identify the technical challenges of adhesive bonding and sealing of metallic engine components to polyamide parts
  - Determine what combination of part design and adhesive technologies are needed to meet the manufacturing assembly, long-term sealing requirements and field serviceability needs.
  - The project was completed in 2010

Composite Challenges

- Differences in CLTE
- Adhesion Properties
- Part Warpage
- Thermoplastic Creep
- Design Robustness
- Under hood Environment
  - Temperature
  - Fluid Resistance
  - Road Impact



Composite Challenges

Coefficient of Linear Thermal Expansion (CLTE)

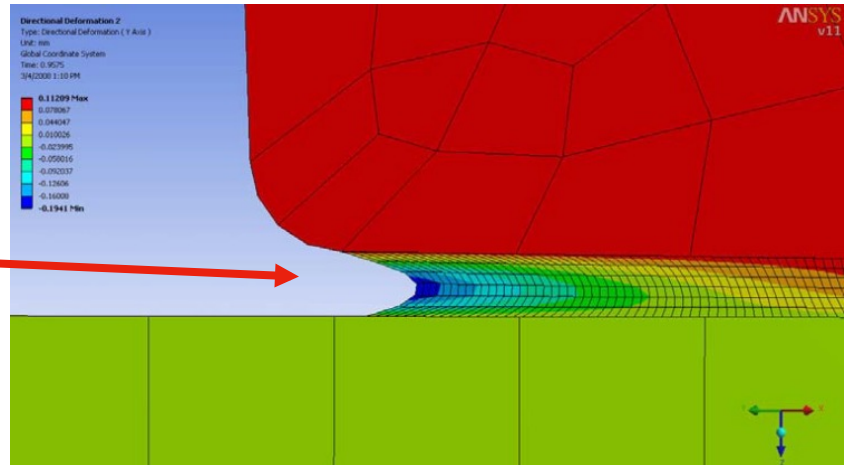
- **Coefficient of thermal expansion:**
- Local fiber orientation
- Ultramid A3WG7 Flow — 18×10^{-6} m/m·K
- Ultramid A3WG7 Cross flow — 65×10^{-6} m/m·K
- Nylon 6/6 — 80×10^{-6} m/m·K

Source: *BASF Ultramid® from 23 to 130°C*

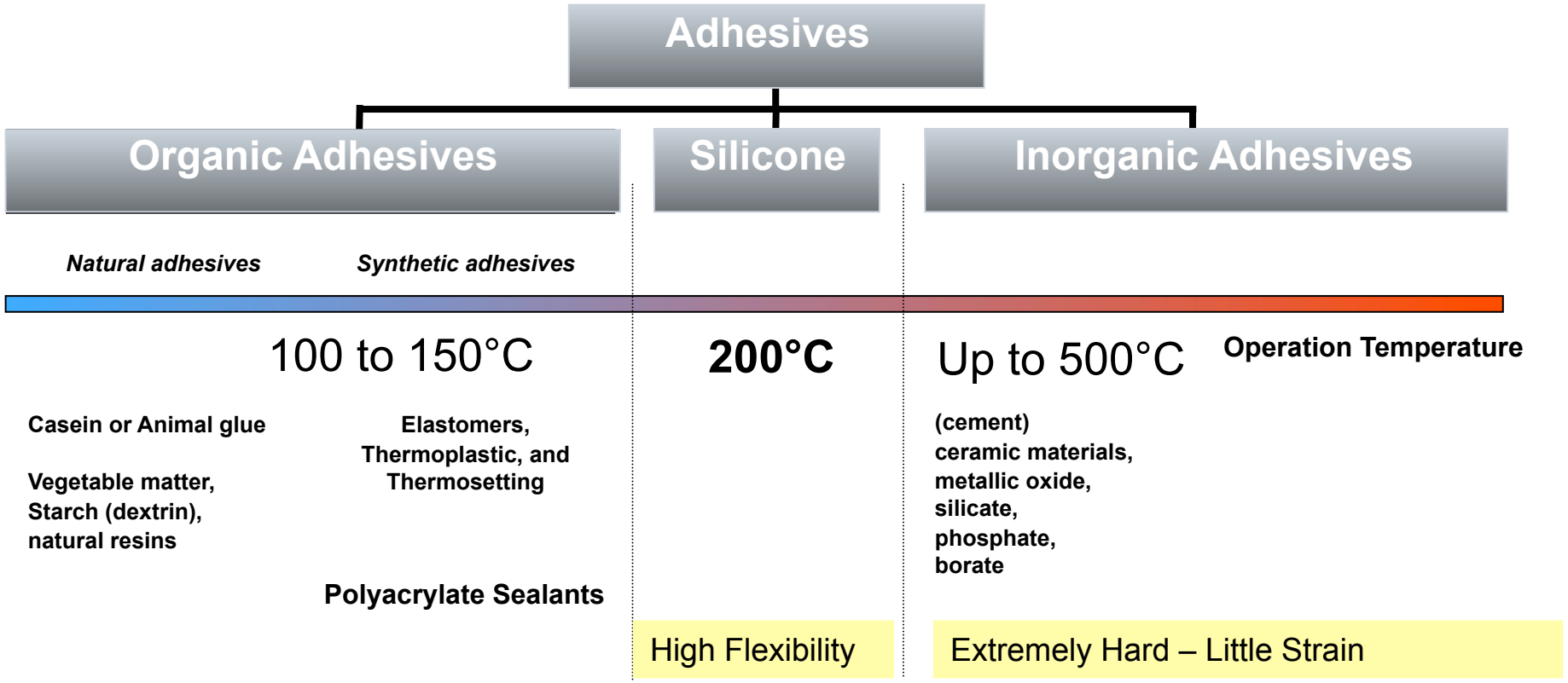
- Aluminium — 24×10^{-6} m/m·K
- Steel — 13×10^{-6} m/m·K

IMPACT TO GASKET

High Stress Load
2 to 4 times the expansion rates
Joint requires a high elongation sealant (400-500%)



Sealant Selection – What's Available?



Source: Wikipedia

Silicone sealants offer the best overall properties of elongation, temperature, adhesion, chemical resistance & history for engine components.

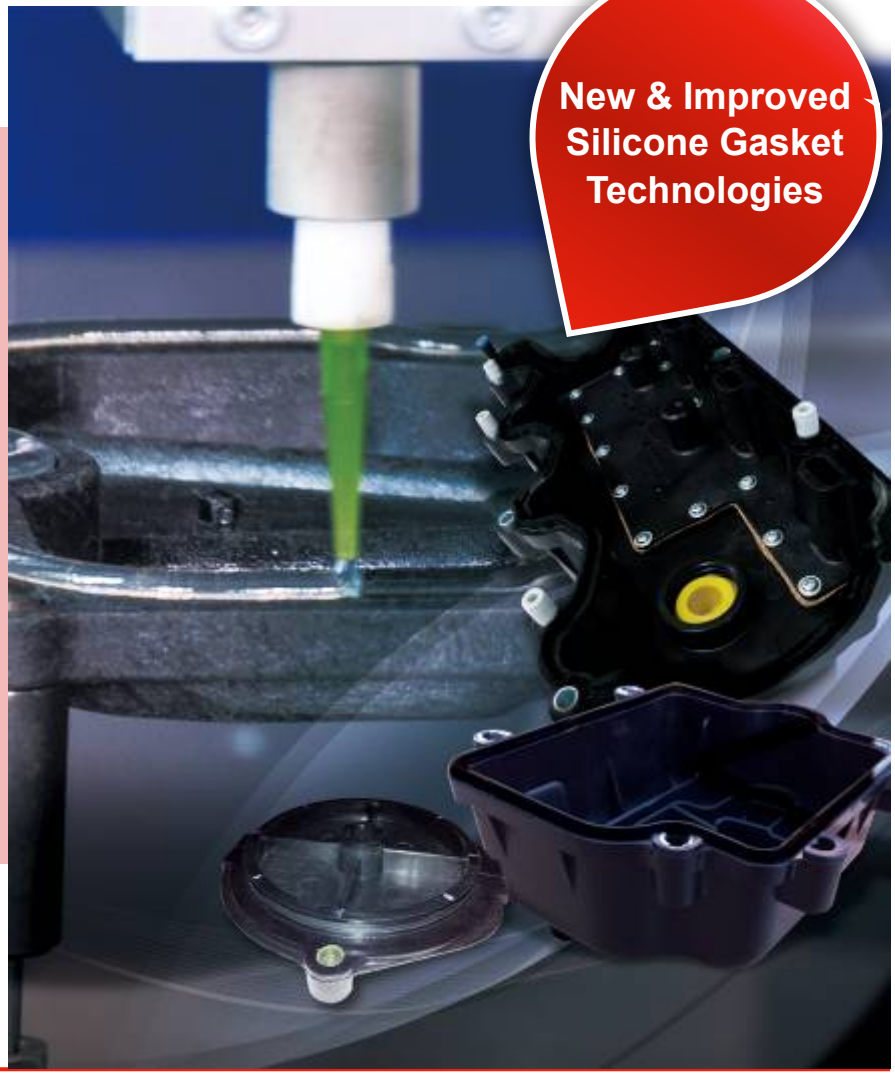
Henkel

Liquid FIPG Solutions

1-Part and 2-Part Silicone Liquid Gasket

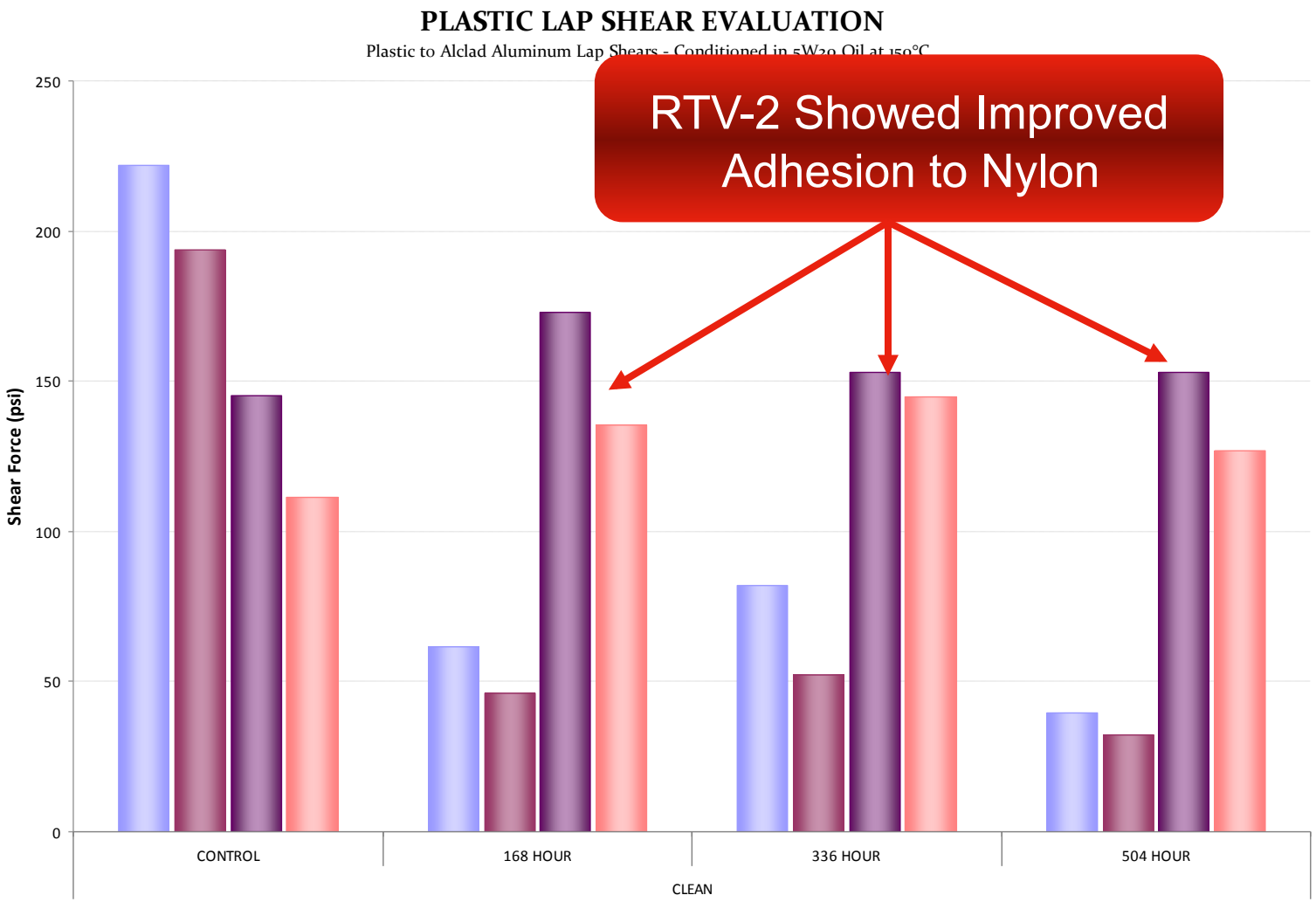
FEATURES AND BENEFITS

- **Enables use of light-weight material**
- **Very good adhesion on plastic substrates**
- **High elongation (500%)**
- **Very good oil resistance**
- **Very good high temperature resistance**
- **Long successful history on Powertrain flanges**



Composite Challenges

Adhesion Properties



What does the future hold?

High Performance Gasket Development

Polyacrylate Gasket Technologies

FEATURES AND BENEFITS

- **Excellent oil resistance (up to 8X better than silicone)**
- **Excellent gas permeation resistance (up to 10X better than silicone)**
- Non corrosive
- Does not promote oil foaming unlike other sealants
- Good adhesion to metal / magnesium alloy and plastic substrates

Also available in UV-cure version for ready-to-use high performance compression gaskets.

High Performance Gasket Development

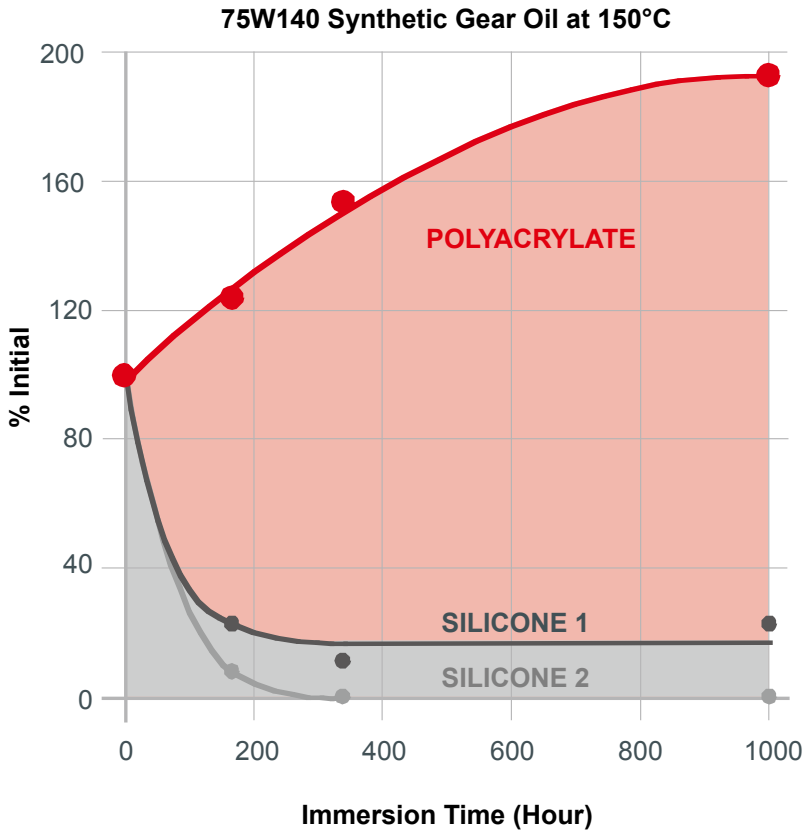
Polyacrylate Gasket Technologies

IMPROVED DURABILITY

In contact with engine oil, Polyacrylate gaskets improve over time while silicone's performance drops.

LIGHTWEIGHT BENEFITS

Allows the use of a liquid sealant in more aggressive environments. Replacement of steel with aluminum, magnesium or plastics for heavy duty truck market, axle and transmissions, diesel engines, etc.



High Performance Gasket Development

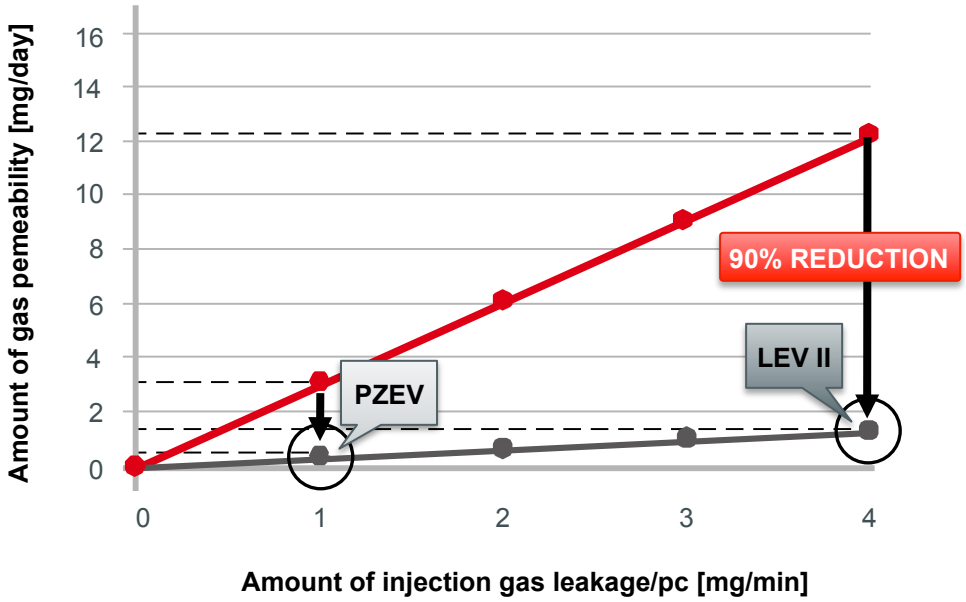
Polyacrylate Gasket Technologies

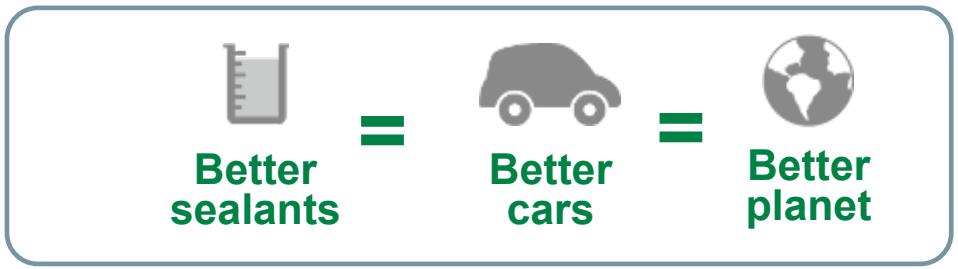
IMPROVED DURABILITY

In contract with engine oil, Polyacrylate gaskets improve over time while silicone's performance drops.

GREENER TECHNOLOGY

Gas permeation resistance is up to 10 times better than "market standard" silicone.





Conclusions

- Market is being driven by CAFE requirements to increase the overall vehicle MPG (54.5 MPG by 2025) and reduce fuel consumption
- Overall vehicle weight and cost need to be reduced to improve the vehicle efficiency and offset the added cost required to improve MPG
- The use of plastic and light weight metals offers design alternatives to reduce weight and cost for improved MPG over traditional methods
- Advancements in liquid FIPG technologies allow for integration of plastic and light weight metals into vehicle Powertrain development

Thank you!