

# DIC.PPS a Contribution to the Decarbonization of the Powertrain

September, 8<sup>th</sup>, 2022

Guido Pengemann  
Sales Representative



# DIC and Sun Chemical



Company Name	<b>DIC Corporation</b>
Corporate Headquarters	DIC Building, 7-20, Nihonbashi 3-chome, Chuo-ku, Tokyo, Japan
Date of Foundation	February 15, 1908
Paid-in Capital	¥96.6 billion
Description of Business	Manufacture and sale of printing inks, organic pigments and synthetic resins
Number of Employees	Consolidated: 20,474 Nonconsolidated: 3,681 (As of December 31, 2021)
Number of Group Companies	189 (Domestic: 29, Overseas: 160) (As of December 31, 2021)
Consolidated Net Sales	¥855.4 billion (Fiscal year 2021) (approx. \$7.9 billion USD)
Consolidated Operating Income	¥42.9 billion (Fiscal year 2021)



Corporate Headquarters

Corporate Introduction Video



<https://www.dic-global.com/en/about/branding.html#dbv>



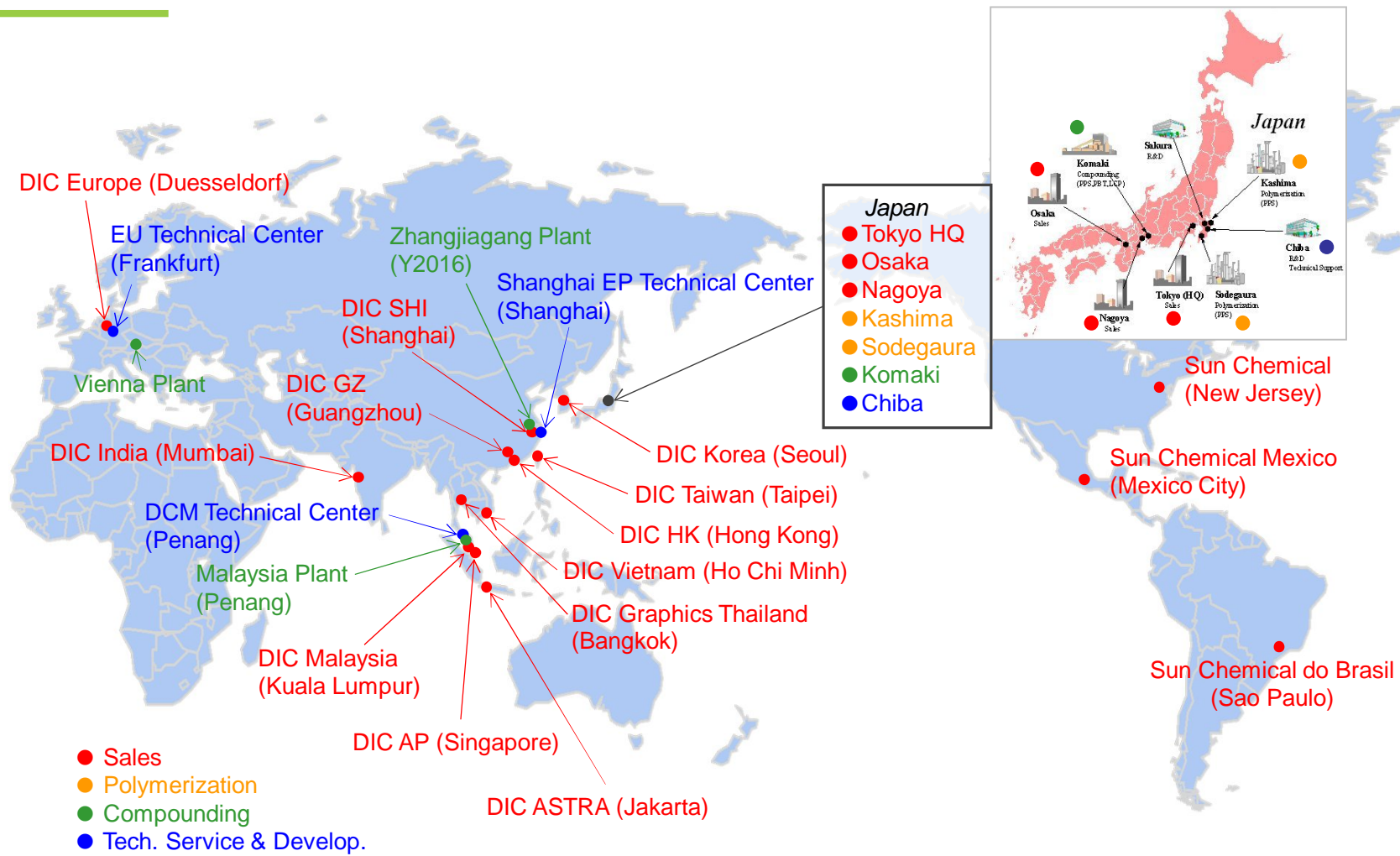
The DIC Group's Brand Slogan

## Color & Comfort

The DIC Group strives to help create a society that adds rich color and comfort to people's lives.

Sun Chemical is the manufacturing, R&D, marketing, and sales arm of the global DIC Group in the Americas, Europe, Africa and Middle East

# DIC.PPS Global Network



# DIC.PPS Production Locations



## Polymer



**Kashima Plant 1**  
Ibaraki, Japan



**Kashima Plant 3**  
Ibaraki, Japan



**Kashima Plant 4**  
Ibaraki, Japan



**Sodegaura Plant**  
Chiba, Japan

## Compounds



**Komaki Plant**  
Aichi, Japan



**DIC Compounds**  
(Malaysia) Sdn. Bhd.  
Penang, Malaysia



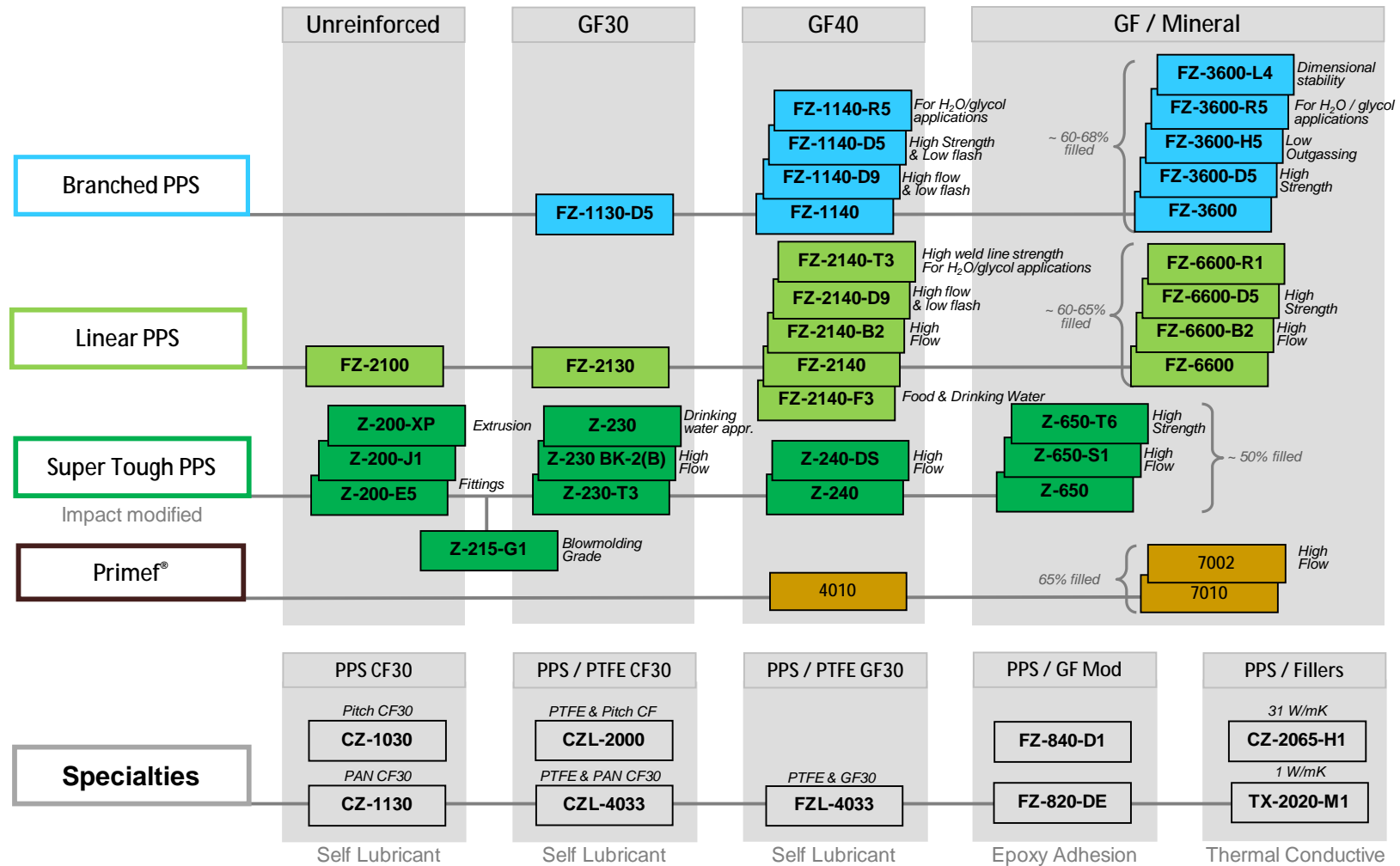
**DIC Europe GmbH**  
Vienna Plant



**Zhangjiagang, China**



# DIC.PPS Product Portfolio



## Outline

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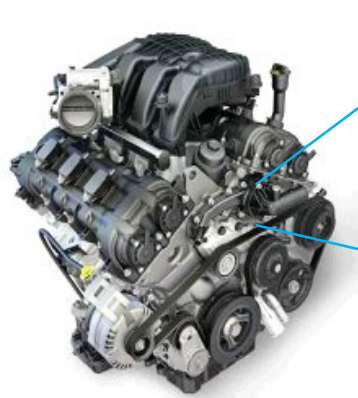


- Injection Molding Grades for Coolant Applications
- Extrusion Grade for Pipe & Tube Applications
- Thermally Conductive Grade
- Injection Molding Grades for LiB Battery Gasket/Insulator
- Laser welding of DIC.PPS

# DIC.PPS Injection Molding Grades for Coolant Applications



DIC.PPS Grade	Filler systems	Key Characteristics
FZ-2140-T3	Linear PPS, 40% GF	Improved hydrolysis resistance and high knitline strength
FZ-1140-R5	Branched PPS, 40% GF	Improved hydrolysis resistance
FZ-6600-R5	Linear PPS, 65% GF/MF	Improved hydrolysis resistance and high knitline strength

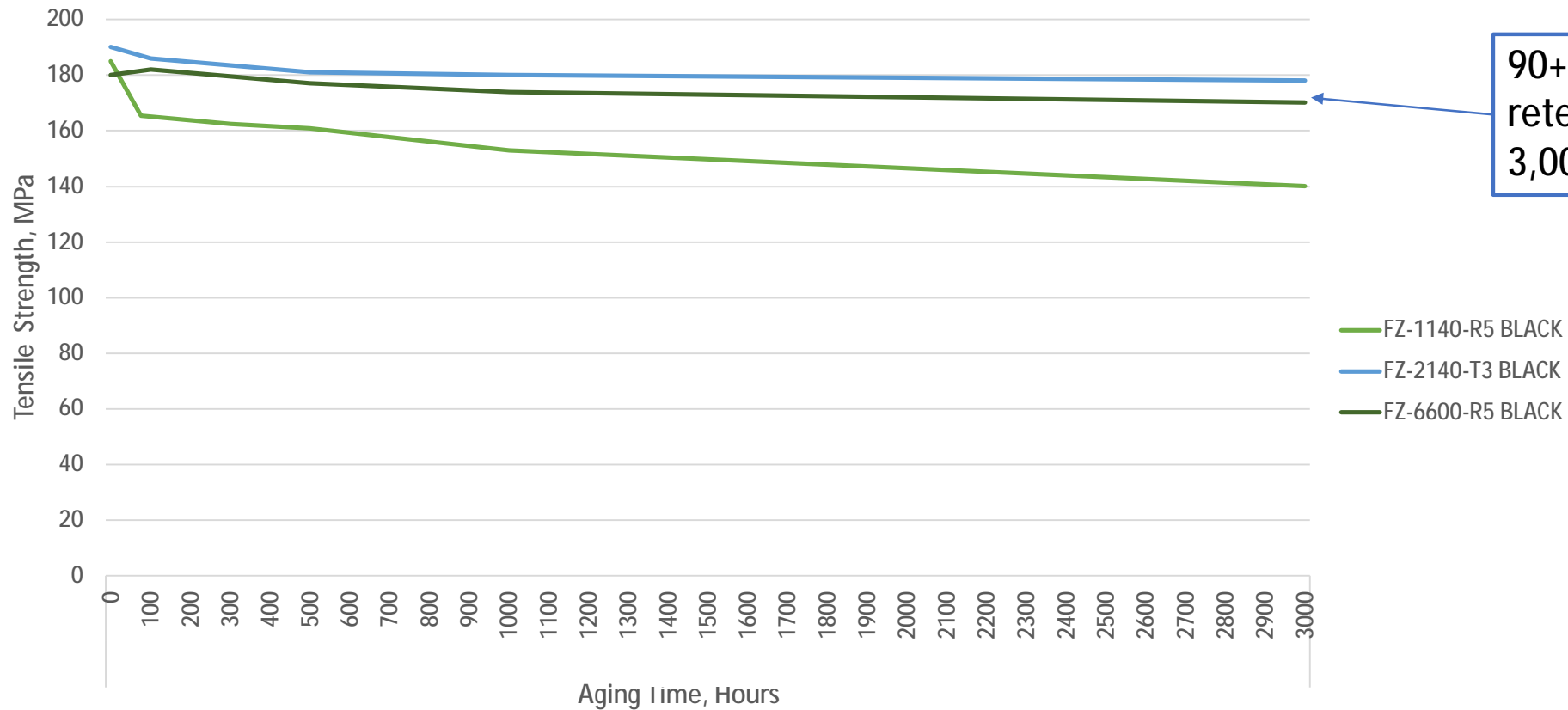


Typical applications are water pump impeller, thermostat, TMM etc. Thermal Management Modules lead to a CO2 reduction of up to 3%

# Coolant Aging Test Results



Tensile Strength, measured at RT after Aging in Toyota Super LLC at 140°C



90+% property retention after 3,000 hrs. at 140°C

FZ-2140-T3 and FZ-6600-R5 show excellent property retention after 3,000 hrs (90+%)



# DIC.PPS Extrusion Grade for Pipe & Tube Applications

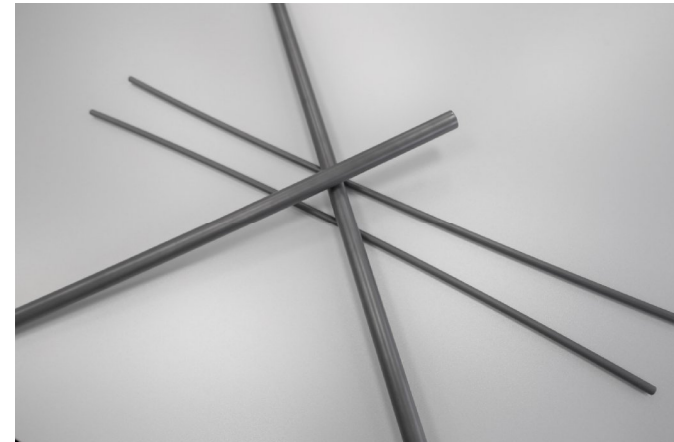


- **DIC.PPS Z-200-XP**

- An unfilled, impact modified, extrusion grade designed for use in pipe and tube applications, especially for automotive coolant lines

- **Key features**

- High viscosity optimum for extrusion process
- Flexibility / elasticity suitable for heat forming process
- Keeping PPS inherent chemical & heat resistance

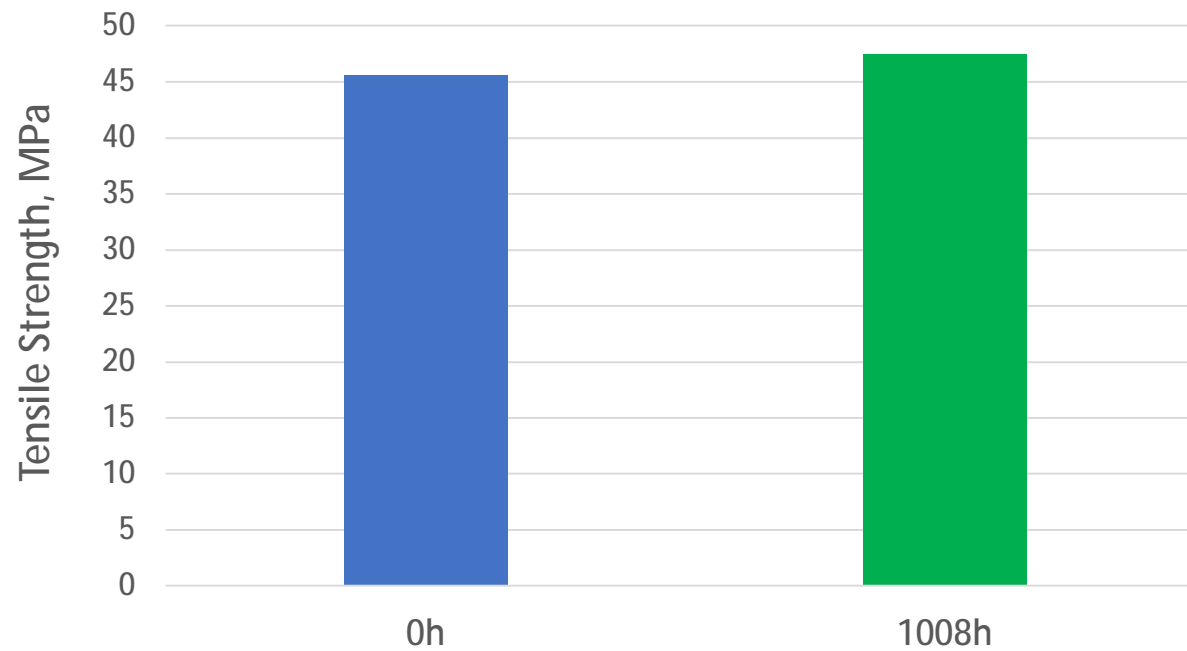


Pipes and tubes made with PPS provide excellent resistance to automotive coolant

## Z-200-XP Coolant Aging Test

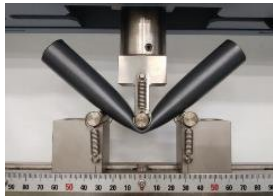


**Aging in Glystantin® G65 / deionized water = 50 / 50 vol% at 135°C**  
(ISO 527, ISO type-A dumbbell)

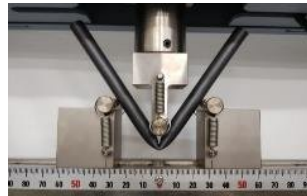


Coolant pipes are designed for high temperature up to 135°C

# Pipe Bending Test



d:22.5 mm  
t: 1.5 mm



d:10 mm  
t: 1.0 mm

- Distance of supports: 64 mm
- Radius of piston and supports: 5 mm
- Piston speed: 1,000 mm/min
- Piston stroke: 32 mm

d:22.5 mm  
t: 1.5 mm



d:10 mm  
t: 1.0 mm



As extruded



After heat aging  
for 48 h at 180 °C



After heat aging  
for 1,000 h at 150 °C

No visible cracks created by bending, even on the tubes after heat treatment

# Air Leak Test



- Air pressure 0.5 MPa (5 bar) applied to the pipes after the bending test



**d: 10 mm pipe  
after heat aging for 48 h at 180 °C**



**d: 10 mm pipe  
after heat aging for 1,000 h at 150 °C**

No air leak from the bended pipes

## DIC.PPS Thermally Conductive Grades



DIC offers a wide range of thermally conductive materials

These materials are commercially used in the field of electric drives, especially for actuator – coil and stator sealing

- Material: DIC.PPS TX-2020-M1
- Key Properties: Thermal conductivity  
Reasonable flow in thin walls  
Dimensional stability

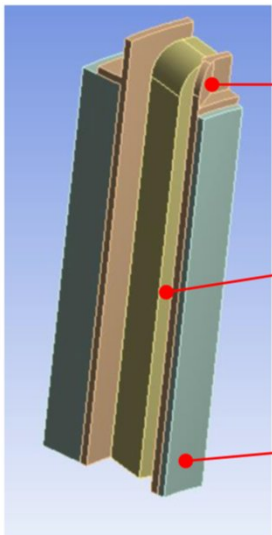


Stator coil

# Thermal Analysis Case Study for Insulator Application



(Software) ANSYS 19.2  
(Material) TX-2020-M1  
PPS GF40% (FZ-2140)

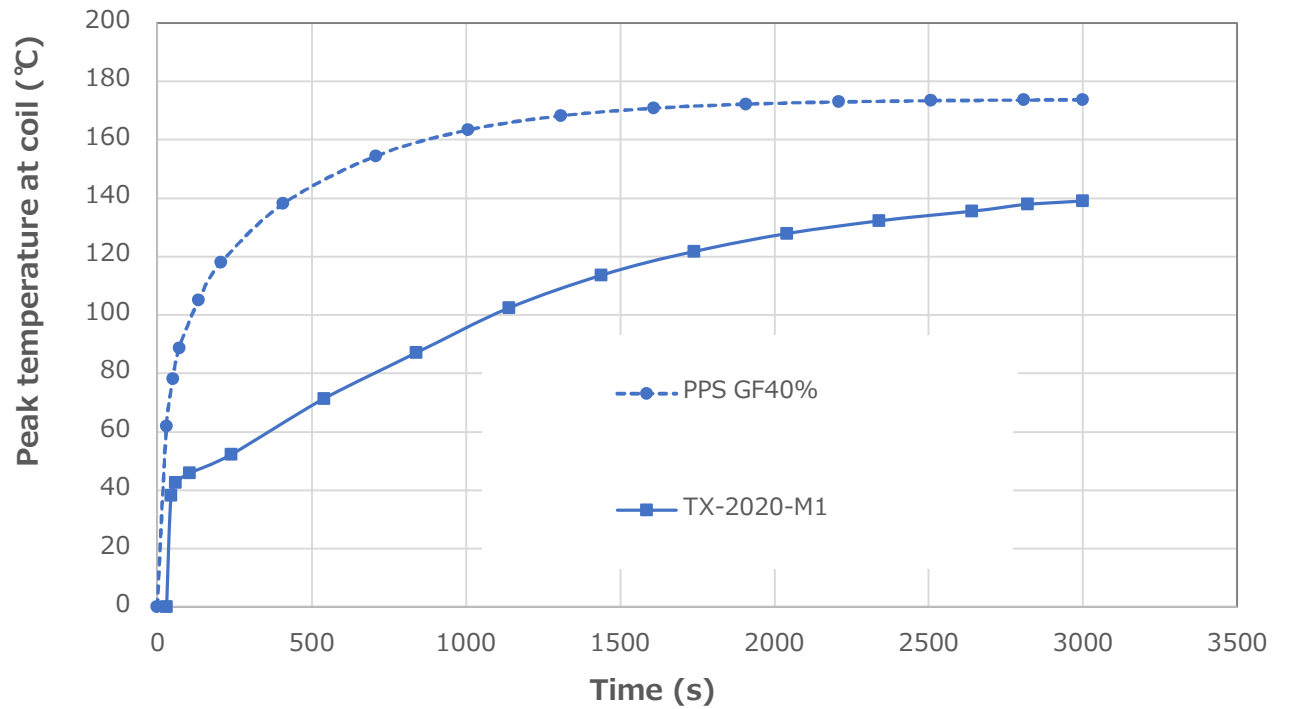


Insulator  
FZ-2140 or TX-2020-M1

Coil  
Oxygen-free copper C 1020

Core  
Copper 50PN470

### Coil temperature increase (1 mm Insulator)



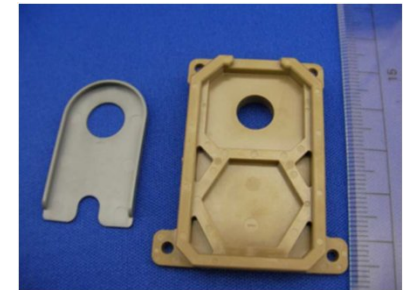
Highly thermally conductive insulator reduces coil temperature by 30°C or more



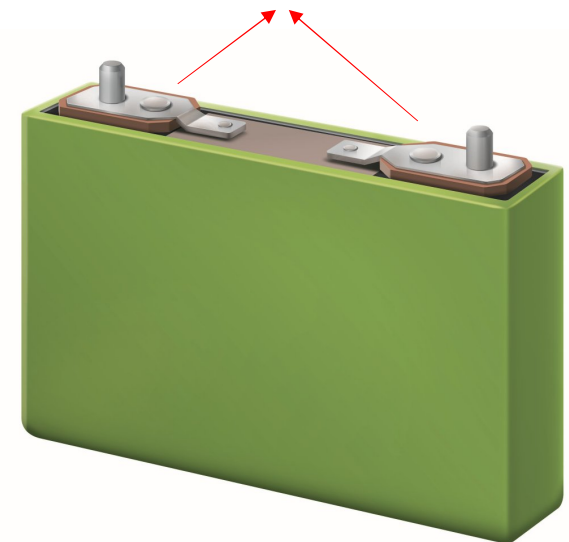
## DIC.PPS for Lithium-ion Battery Cells

- **DIC.PPS FZ-2100 and Z-200-E5/E2**
  - Ø Unfilled injection molding compounds for Lithium-ion Battery (LiB) gaskets
- **DIC.PPS FZ-1140-D5**
  - Ø Glass fiber reinforced injection molding compound for LiB cell insulators
- **Key Requirements:**
  - Ø Chemical resistance to electrolyte
  - Ø Resistance to compressive stress
  - Ø Electrical insulation – high dielectric strength
  - Ø Keeping PPS inherent flame retardancy

DIC.PPS provides excellent chemical resistance to LiB cell electrolytes  
Superior insulation properties and resistance to compressive stress



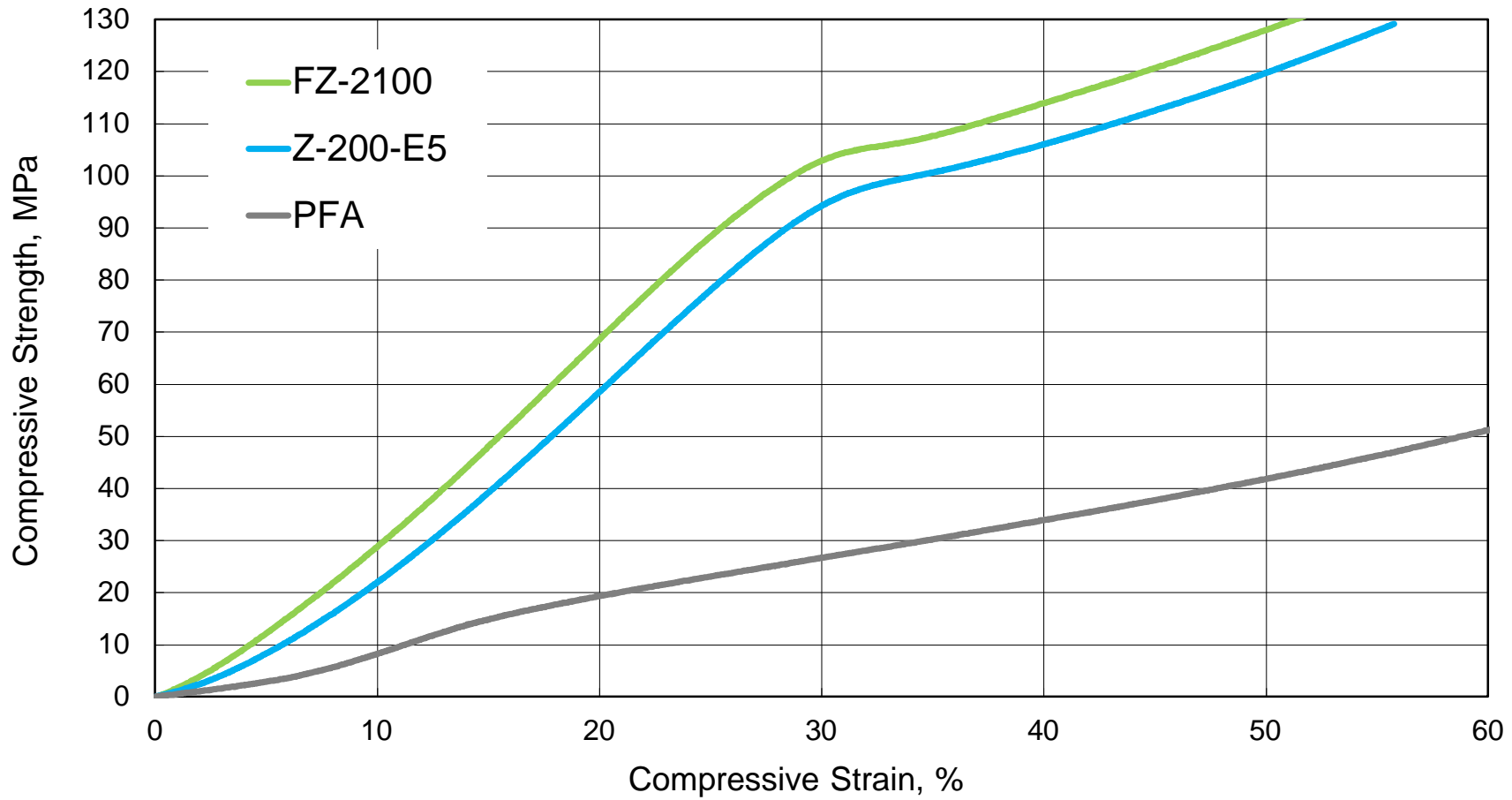
Insulator/Gasket



# DIC.PPS for LiB Battery Gasket/Insulator



Compression S-S curve (3 mm), 70°C



# Laser Welding of DIC.PPS



## § Objective

To demonstrate the feasibility of laser welding DIC.PPS on containers with the support of Evosys Laser GmbH.

The containers consist of a housing and a cover.

## § Welding technology

- Ø Process: contour welding and quasi-simultaneous welding
- Ø Equipment: Evosys Next Generation Optics (NGO)



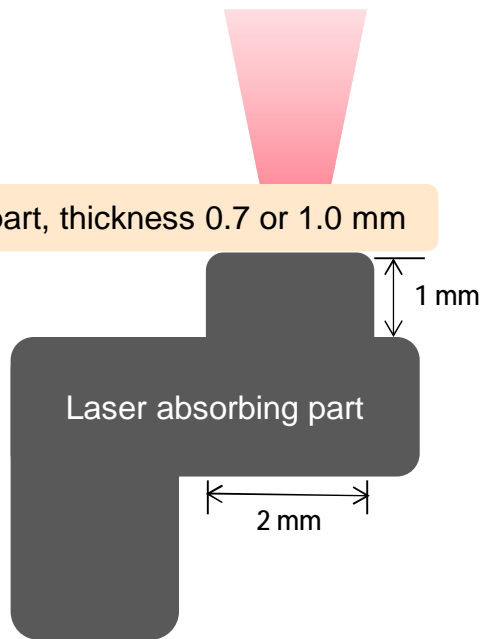
Laser welding tests were completed on standard PPS grades

# Laser Welded Samples



## § Samples

- ∅ Laser absorbing part: cup-shaped specimen (original DIC design):  
DIC.PPS FZ-2140 BLACK >PPS-GF40<
- ∅ Laser transparent part: flat plate specimen of thickness 0.7 mm and 1.0 mm:  
DIC.PPS FZ-2115 >PPS-GF15<  
DIC.PPS FZ-2140 >PPS-GF40<



Samples welded by Evosys Laser GmbH

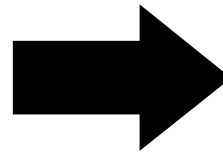
# Burst Pressure Test - Experiment



1. Fill with water



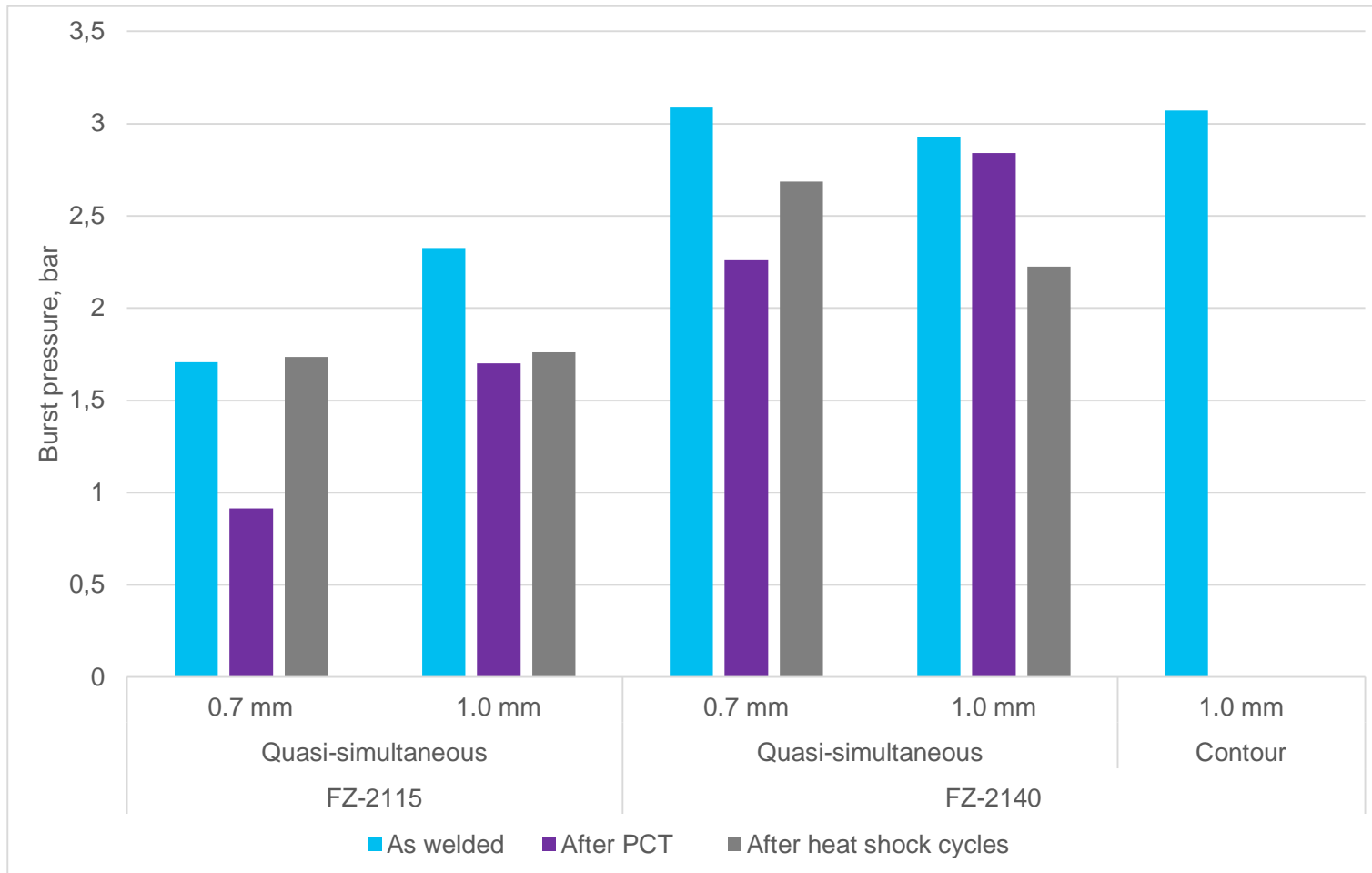
2. Connect to the pump



3. Increase the water pressure until it bursts



# Burst Pressure Test - Results







**Thank you very much for your attention!**

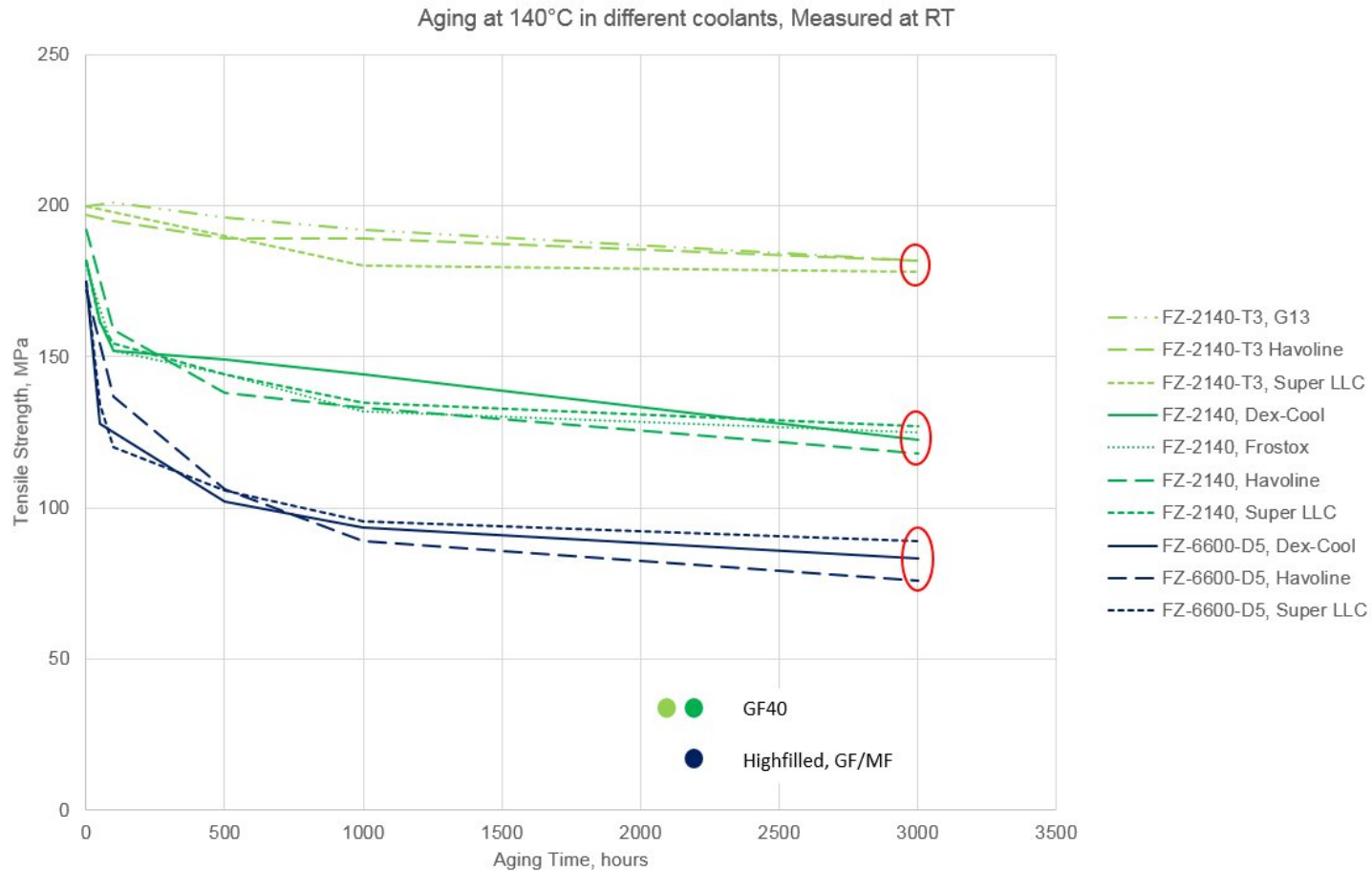
**Any Questions?**



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# APPENDIX

# Aging in different coolants



Tests with different coolants show very similar aging properties after 3000 hours at 140°C

## Contour welding

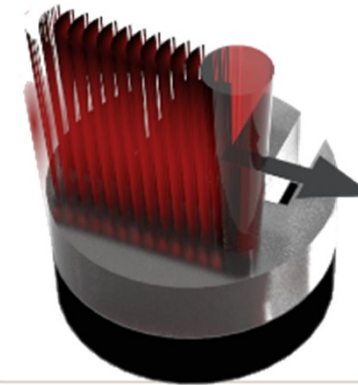
Just one pass  
« slowly »



- § Characteristics:  
Laser beam passes over the welding path only once
- § Relative movement:  
Laser beam or joining part (e. g. by axis system, robot)
- § Process Control:  
Temperature control and optical systems
- § Typical Applications:  
Huge parts or 3-D joints

## Quasi-simultaneous welding

Several rounds  
« quickly »



- § Characteristics:  
Laser beam passes over the welding path several times with a high feed rate
- § Relative movement:  
Laser beam guided by a galvanometric scanner
- § Process Control:  
Collapse control
- § Typical Applications:  
Small and medium sized parts