

### Advanced Copo = higher robustness: Opening new applications for glass-fiber reinforced Polypropylene

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## **Opening new applications for glass fiber reinforced Polypropylene**

# Agenda

- **EV New technologies with changing requirement for polymers**
- Characteristic differences of Advanced Copo vs. conventional PP Compounds
  - Cyclic load conditions Fatigue
  - Constant load conditions Creep
  - Increased Lifetime Relevant Load (LRL)
  - Material performance in contact with cooling agent
  - Product design adapted to the selected production process
    - using hot plate welding
    - using LASER welding
- Basic material polymerization concept of Advanced Copo
- Advanced Copo PP and sustainability: CirculenRenew

Electric mobility results in new technologies with changing requirement for polymers

ADAC field service: Failure statistics for Germany 2020 (av. car age 9,8 years)

## **COMBUSTION VEHICLES**

### **ELECTRIC VEHICLES**



Electric mobility results in new technologies with changing requirement for polymers



**Opening new applications for glass fiber reinforced Polypropylene** 

### washing machine pulley



### surge tanks

### cooling pipe connectors



with courtesy of MANN+HUMMEL France



Impact of cyclic load
 Fatigue (Lifetime Relevant Load)

5

**Opening new applications under cyclic load** 

## Fatigue failure = break or plastic yield

caused by cumulated material damage and/or fracture propagation due to applied small cyclic load



## "Lifetime Relevant Load" (LRL):

- > How many load cycles the structure will be able to sustain without failure?
- > Maximum load level the structure will be able to sustain without failure within a given number of cycles?

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**Opening new applications under cyclic load** 

■ Tensile fatigue – Wöhler curves, T=120°C, R=0.1, f=5Hz



**Opening new applications for glass fiber reinforced Polypropylene** 

### washing machine pulley

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with courtesy of MANN+HUMMEL France

LYB with courtesy of JoinPlas GmbH

- Impact of cyclic load
  Fatigue (Lifetime Relevant Load)
- Impact of constant load
  Creep (Lifetime Relevant Load)
- Effect of cooling agent
- Hot plate welding

- Impact of constant load
  Creep (Lifetime Relevant Load)
- Cooling agent Conductivity
- LASER welding

**Opening new applications under constant load** 

## **Creep failure = break or plastic yield**

caused by increasing viscoelastic material deformation due to applied small load



"Lifetime Relevant Load" (LRL):

- > How long the structure will be able to sustain without failure?
- > Maximum load level the structure will be able to sustain without failure within a given time?

**Opening new applications under constant load** 

- Tensile creep, 130°C
  - HOMO PP-GF10
  - Adv. COPO PP-GF10

- 4.0 mm thickness
- according to ISO 527-2/1A
- test temperature = 130°C



**Opening new applications under constant load** 

Creep to rupture curves (CTRC), 130°C





• Adv. COPO PP-GF10

- 4.0 mm thickness
- according to ISO 527-2/1A
- test temperature = 130°C

**Opening new applications under constant load** 

Creep to rupture curves (CTRC), 120°C



- HOMO PP-GF37
- Adv. COPO PP-GF37
- Adv. COPO PP-GF30

- 4.0 mm thickness
- according to ISO 527-2/1A
- test temperature = 120°C

Impact of cooling agent immersion on tensile stress at break



- + Adv. Copo PP-GF10
- Adv. Copo PP-GF20
- Adv. Copo PP-GF30
- **+** Polyamide PA66-GF30

- 4.0 mm thickness
- according to ISO527-2/1A
- test temperature = 23°C
- commercial cooling agent
- immersion temperature = 90°C

Impact of cooling agent immersion on impact strength



- + Adv. Copo PP-GF10
- Adv. Copo PP-GF20
- Adv. Copo PP-GF30
- ✤ Polyamide PA66-GF30

- 4.0 mm thickness
- according to ISO527-2/1A
- test temperature = 23°C
- commercial cooling agent
- immersion temperature = 90°C

**Opening new applications for glass fiber reinforced Polypropylene** 

### washing machine pulley





surge tanks

with courtesy of MANN+HUMMEL France

cooling pipe connectors



- Effect of cyclic load
  Fatigue (Lifetime Relevant Load)
- Effect of constant load
  Creep (Lifetime Relevant Load)
- Effect of cooling agent
- Hot plate welding

- Effect of constant load Creep (Lifetime Relevant Load)
- Cooling agent Conductivity
- LASER welding

Impact of material immersion on cooling agent conductivity



immersion temperature = 90°C

### LASER weldability – transmission at 950 nm



#### cooling pipe connectors



with courtesy of JoinPlas GmbH

tested on inj. molded plaque

- Advanced Copo PP-GF30 •
- $\lambda = 950 \text{ nm} (\text{LED})$

## Advanced Copo = higher robustness Spherizone Technology – Key for unique polyolefins

### **Multi Zone Circulating Reactor**

- One polymerization reactor with two separate reaction zones
  ✓ Unique Platform
- Mixed Phase (Gas-Liquid) Technology
  - ✓ No limitations in terms of gas-phase composition ( $H_2$ ,  $C_2$ , ...)
  - ✓ Suitable for high pressure and temperature
- Superior Product Homogeneity
  - $\checkmark$  One reactor for bimodal grades
  - ✓ Residence time distribution does not have an influence on homogeneity
- High Productivity
  - ✓ Fully able to exploit LyondellBasell morphology-controlled catalyst

## New field of tailor-made polymers



## **Opening new applications for glass fiber reinforced Polypropylene**

### Advanced Copo offers characteristic benefits vs. conventional PPCompounds for

- Cyclic load conditions Fatigue
- Long term load conditions Creep

#### Advanced Copo PP-GF are available for

- Applications in contact with cooling agent
- Specific production process
  - using hot plate welding
  - using LASER welding

#### Potential sustainable solution for "Advanced Copo PP": CirculenRenew



Increased Lifetime Relevant Load (LRL)



# Appendix

MME 2022

20

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**Opening new applications under constant load** 

- Tensile creep, 130°C
  - HOMO PP-GF10
  - Adv. COPO PP-GF10



tested on inj. molded specimens

- 4.0 mm thickness
- according to ISO 527-2/1A
- test temperature = 130°C



[1] A. Berthold, Polymer Service GmbH Merseburg

**Opening new applications under constant load** 







tested on inj. molded specimens

- 4.0 mm thickness
- according to ISO 527-2/1A
- test temperature = 130°C

[1] A. Berthold, Polymer Service GmbH Merseburg

**Opening new applications under constant load** 

Creep to rupture curves (CTRC), 110°C



### • Adv. COPO PP-GF30

- 4.0 mm thickness
- according to ISO 527-2/1A
- test temperature = 110°C

Impact of material immersion on cooling agent conductivity



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