



## Prototypenguss für den Leichtbau in 3D-gedruckten Sandformen für komplexe, große Strukturgussteile



## Company





- Established in 1963
- Family owned business
- 3 production sites in Germany
- 210 employees
- 3 business areas: casting, tooling, automation

### **Extensive experience in thin-wall aluminum sand castings!**

# Tendency to Larger Castings like RUB/FUB *GRUNEWALD*<sup>®</sup> with Multiple Integrated Parts





BIONEQXX Rear Floor of Mercedes-Benz VISION EQXX

**BMW Battery Structure** 

### Large RUB/FUB and Large Battery Housings

## GRUNEWALD

## **3D Sand Printing**



### Grunewald operates two 3D sand printers

# Typical BIW and Structural Castings, State of the Art



#### Typical values for mechanical properties

Relevant for crash and strength, Material a356 T6 (AlSi7Mg 0,3) Rp0,2: > 120 [Mpa], Rm: > 180 [Mpa], A5: > 10 % Rp0,2: > 180 [Mpa], Rm: > 240 [Mpa], A5: > 8 % Rp0,2: > 220 [Mpa], Rm: > 250 [Mpa], A5: > 5%



Typical as cast tolerances and wall thicknesses

+/- 0,8 mm > 2mm (+/- 0,3 mm)



Typical as cast surface quality

Ra (μm) ca. 6,8 Rz (μm) ca. 26



- BIW castings: shock towers, beams, A-, B-, C- pillar geometries, roof-, window- and door geometries, enforcements, brackets, nodes, connecting parts, ...
- Chassis castings: subframes, steering knuckles, beams, rods, ...
- Battery castings: housings, covers, ...

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# Typical BIW and Structural Castings, State of the Art



Sand casting process chain

# Tendency to Larger Castings like RUB/FUB *GRUNEWALD*<sup>®</sup> with Multiple Integrated Parts





source: Aachen University, Foundry Institut, 2010

### (Mega) Rear Under Body

- Dimensions: ca. 2,000 mm \* 1,800 mm \* 750 mm
- Wall thicknesses between 2,8 mm ca. 8mm
- Weight: ca. 55 kg

- Alloy AlSi7Mg0,3 T6
- Hypoeutectic solidification
- Sufficient feeding rates of saturation

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source: Grunewald, 2023

- X-Ray inspection to ASTM E155 Level 3 is accepted and documentation of Level 3 limit displays
- Dye-penetrant inspection, according to EN3452-1

|                   | YTS [MPa] | UTS [MPa] | E [%] |
|-------------------|-----------|-----------|-------|
| required values   | ≥ 130     | ≥ 220     | ≥ 5   |
| values test bar 1 | 145       | 223       | 7.8   |
| values test bar 2 | 146       | 220       | 8.0   |

source: Grunewald, 2023

• AISi7Mg0,3 T6 mechanical properties with air quenching

# Specific Requirements from OEMs *GRUNEWALD*<sup>®</sup> for Large Castings



### Forming dimensions and weight

- Forming Dimensions: ca. 2200 mm \* 2000 mm \* 1200 mm
- Mold weights up to 10t



Weight of raw part = 55Kg Total casting weight = ca. 150 Kg

# Challenges, Possibilities and Limitations *GRUNEWALD*<sup>®</sup> of Large Structural Castings



Low Pressure principle, ascending filling and after pressure



## Requirements for large rear and front underbody castings

- Melting capacity e. g. 720 kg
- Multiple ascending pipe system (e. g. 5)

### **Characteristics**

- Specified pressure/time definition
- Process control
- Repeatable process
- Differenciated casting system
- Feeding and cooling technology
- Ascending mold filling
- Laminar mold flow
- Controlled after pressure
- Fluid shrinkage control

#### Grunewald GmbH & Co. KG

#### Low Pressure Sand Casting

## **Conclusion and Outlook**



### Conclusion

- Forming and casting of large RUB/FUB castings are possible ( ca. 2 per week)
- Special casting systems are required
- Air quenching is needed after solution heat treatment and in front of artificial aging
- Equipment for weight and volume handling of sand mold is needed

#### Outlook

- Forming and casting of large RUB/FUB castings up to 10 per week
- Dimensional as cast (raw part) tolerances +/- 1,5mm
- Wall thicknesses <3mm
- Large part forming line for higher quantities in planning