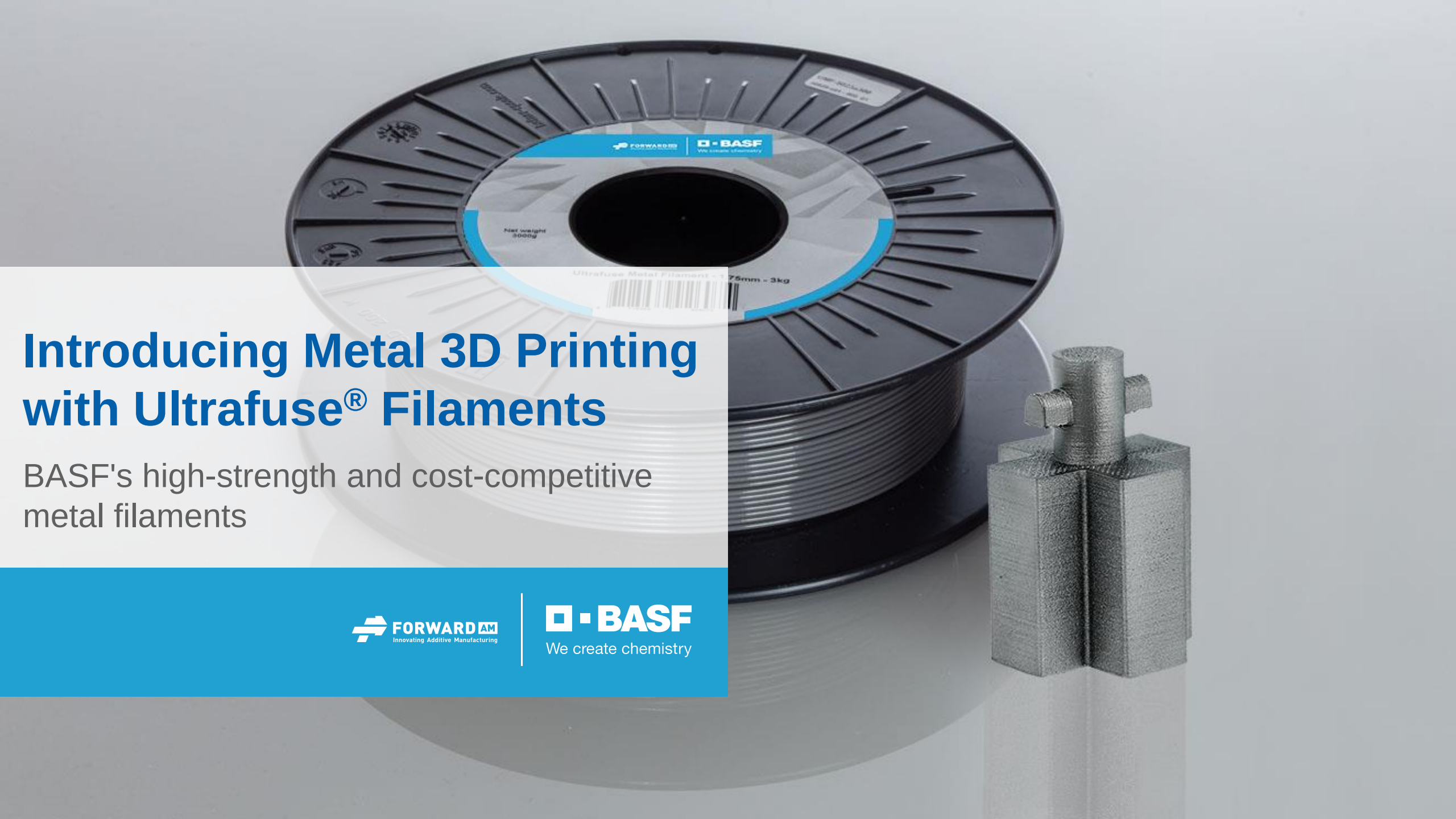


Introducing Metal 3D Printing with Ultrafuse® Filaments

BASF's high-strength and cost-competitive metal filaments

FORWARD AM
Innovating Additive Manufacturing

BASF
We create chemistry

Agenda

1. What is Metal FFF?
2. Ultrafuse® Metal Filaments Portfolio
3. SPAROX 3D Use Case – Ultrafuse® 17-4 PH
4. hoedtke 3d additive Use Case – Ultrafuse® 316 L
5. Cost Calculation Example
6. How does it work for you?

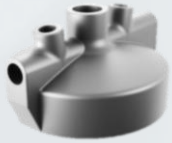
BASF We create chemistry | FORWARD AM Innovating Additive Manufacturing

What is Metal FFF?

Metal powder combined with a binder system to create a filament suitable for FFF 3D printers.

Full metal part reached in 3 step process: printing, debinding and sintering.

Step 1: Printing

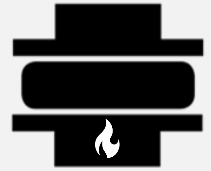


Green Part

Step 2: Debinding

Brown Part

Step 3: Sintering



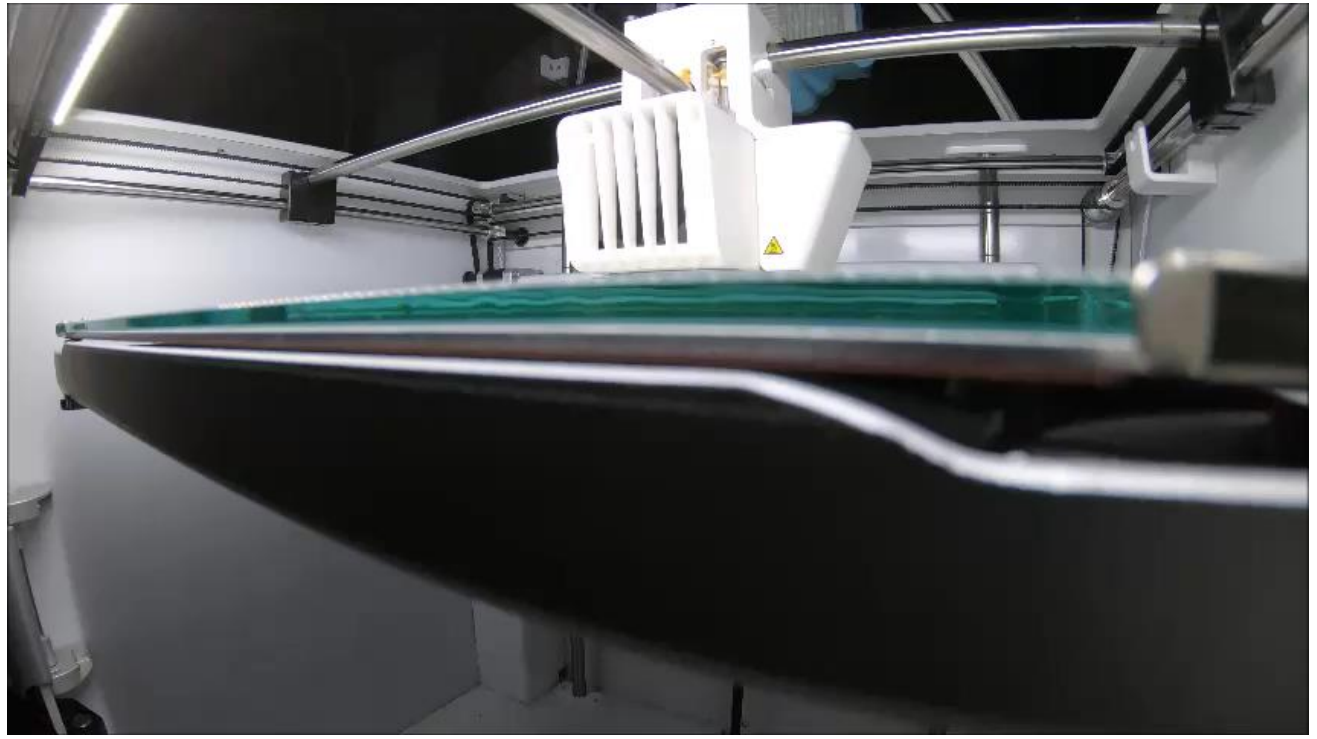
Final Part

Very well-known MIM Industry standard!

BASF We create chemistry | FORWARD AM Innovating Additive Manufacturing

What is Metal FFF?

Printing of the “Green Part”:



BASF
We create chemistry

FORWARD AM
Innovating Additive Manufacturing

Forward AM's Ultrafuse® Metal Filaments Portfolio

- Enables one of the most competitive metal printing.
- Compatible with all open source FFF printers.
- Very easy to handle.
- Debinding and sintering service offered via D&S network.
- Easy to use support material under development.
- Strong R&D pipeline: More than 10 metals like Titanium and Inconel have been tested in 2020.

Ultrafuse® 316L

Ultrafuse® 17-4 PH

BASF We create chemistry | FORWARD AM Innovating Additive Manufacturing

Ultrafuse® 316L at a Glance

Ultrafuse® 316L…

- is of 316L grade stainless steel.
- is used in food and chemicals industries esp. for the applications that work in high temperature humid environments.
- offers very good corrosion resistance and good mechanical properties.
- is available in 3 kg kg spools.

Potential applications are…

- pipe connectors
- spare parts ie. for packaging lines
- tools, jigs and fixtures

Customised tools, jigs and fixtures

Functional prototyping

Spare parts

Small series production

BASF We create chemistry

FORWARD AM Innovating Additive Manufacturing

Ultrafuse® 17-4 PH at a Glance

Ultrafuse® 17-4 PH…

- is of 17-4 PH grade stainless steel – one of the most used stainless steels in various industries.
- offers better mechanical properties and hardness than Ultrafuse® 316L.
- can achieve better mechanical properties through hardening.
- has good corrosion resistance (although lower than 316L) which makes it a general-purpose stainless steel.
- is available in 3 kg and 1 kg spools.

Potential applications are…

- machinery parts
- spare parts
- tools, jigs and fixtures

Customised tools, jigs and fixtures

Functional prototyping

Spare parts

Small series production

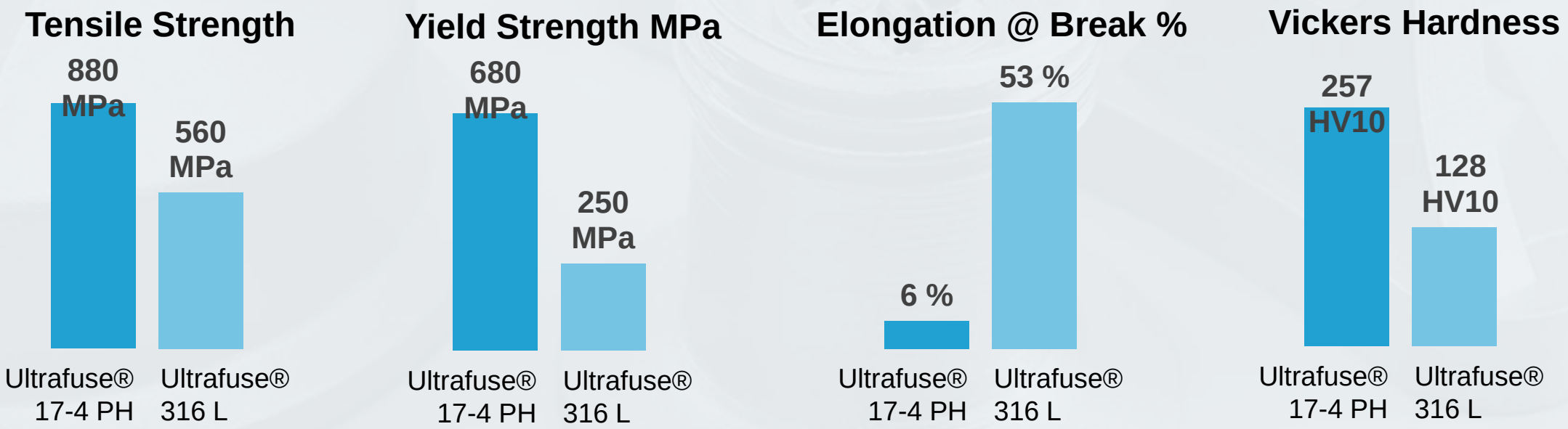
BASF We create chemistry

FORWARD AM Innovating Additive Manufacturing

Ultrafuse® 17-4 PH vs Ultrafuse® 316L

Ultrafuse® 17-4 PH has higher mechanical properties and hardness. This makes it more suitable for general use. Higher hardness could be achieved with heat treatment.

Ultrafuse® 316L has higher corrosion resistance which makes it a material of choice for applications in humid and salty environments.



BASF We create chemistry | FORWARD AM Innovating Additive Manufacturing

SPAROX 3D Use Case with Ultrafuse® 17-4 PH

1. SPAROX is an online marketplace for spare parts mainly used in energy sector. SPAROX also prints and delivers spare parts.
2. SPAROX already had multiple FFF printers inhouse printing thermoplastics.
3. Ultrafuse® 17-4 PH enabled SPAROX to print metal parts without being forced to invest multiple 100K Eurs to a metal printer.
4. Both printed parts, the solar panel clamp and the gate lock, are available at www.sparox.eu and end customers can order finished parts.

Solar Panel Clamp

- Discontinued serial product
- UV, heat, corrosion res. required
- Upgraded to 17-4 PH from Al to increase product life

40,1 x 20,2 x 45,5 mm
98 gr

Gate Lock

- Small-series spare part
- High mechanical strength required

20,1 x 34,5 x 12,2 mm
31 gr

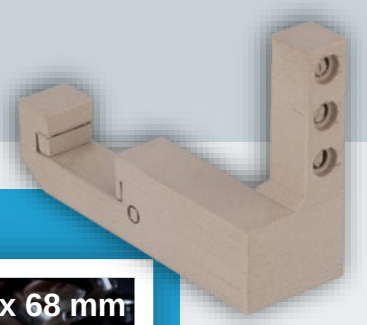
WIEN ENERGIE

BASF We create chemistry

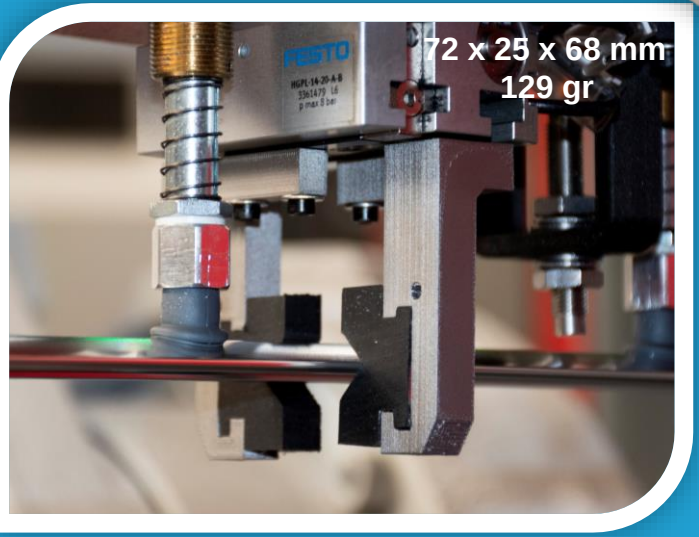
FORWARD AM Innovating Additive Manufacturing

Use Case with Ultrafuse® 17-4 PH

1. WKW.automotive produces high-quality trim and functional parts made of aluminum, stainless steel and plastic for premium-class passenger cars are
2. WKW has a high expertise in FFF printing and has several different printers inhouse
3. Ultrafuse® 17-4 PH enabled WKW to produce on demand designs for their highly automated robotics product lines with reduced costs and lead time
4. The printed robot grippers are tested and mounted in the production



Welding fixture

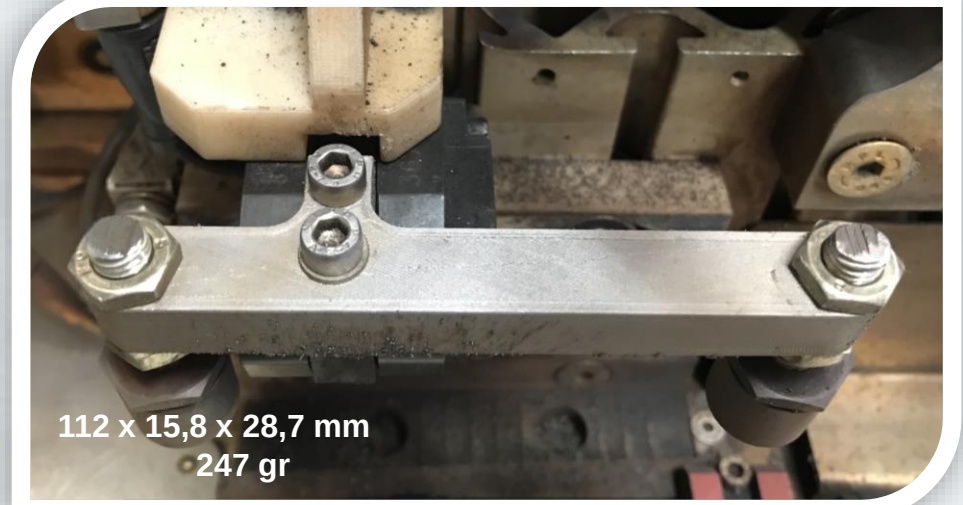


- Fast design adjustments
- Customized solutions for production
- High durability
- Cost-effective design customization

hoedtke 3d additive Use Case with Ultrafuse® 316 L

1. Hoedtke´s expertise lies in various production technologies, including metal processing and metal part production.
2. Hoedtke was looking for an alternative to a 3D printed part in a welding fixture that breaks occasionally.
3. Ultrafuse® 316 L helped Hoedtke to replace it with a very durable 316L part at a very low cost.
4. Part was assembled and tested, after hundreds of cycles, still being used w/out problem.

Welding fixture

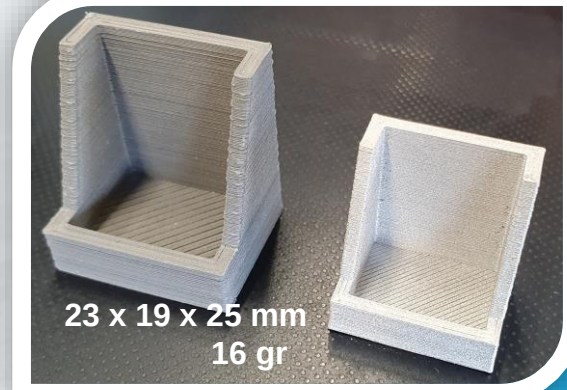


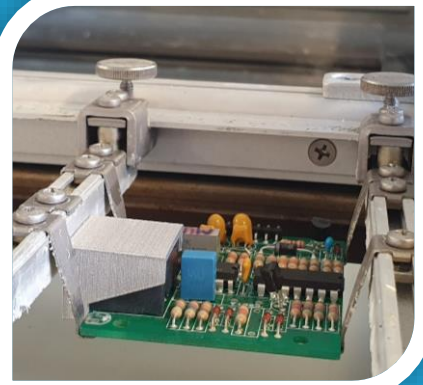
- Original part was ABS
- Redesigned for additive manufacturing
- Durability under high temp. and loads required

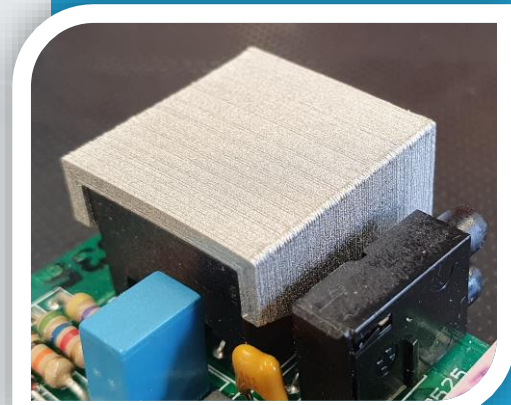
Use Case with Ultrafuse® 316 L

1. SCHORISCH Elektronik is an electronics manufacturing service provider and is specialized in the niche of ATEX
2. SCHORISCH Elektronik uses a wave soldering processes for electronic boards with components of the Through Hole Technology (THT)
3. Ultrafuse® 316 L was the optimal candidate for a temperature-resistant small series for product optimization
4. The component was developed in a very short time and successfully tested in production and is now in use

Production aid





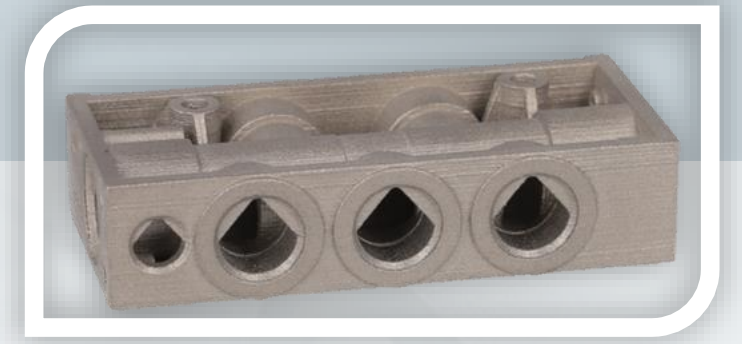


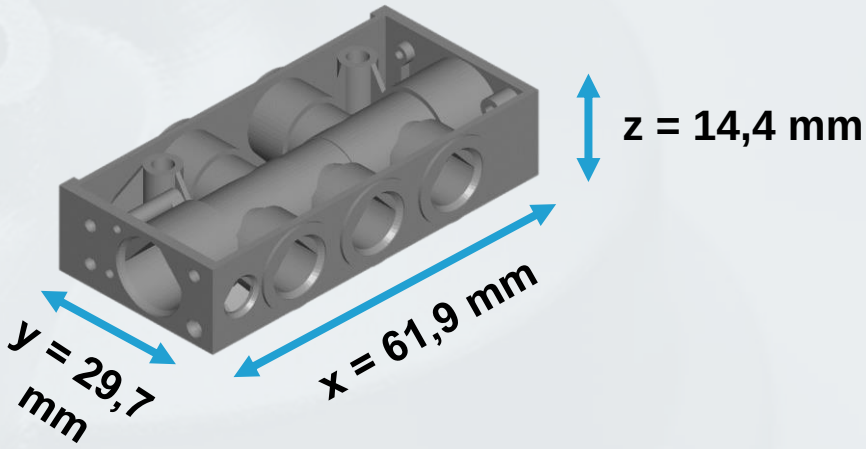
- Original solution with Capton tape
- Sustainable
- Labor reduction
- Scalable
- Durability under high temp. and loads required

SCHORISCH Elektronik made in Germany

BASF We create chemistry | FORWARD AM Innovating Additive Manufacturing

Cost Analysis with Ultrafuse® 17-4 PH





Green part dimensions:	61,9 mm x 29,7 mm x 14,4 mm
Green part weight:	124 gr/part
Printer used:	BCN3D in dual mode
Print time:	23 hours / 8 parts @ once

Material cost:	12,28 Eur/part (99 Euro/KG)
Process cost:	3,80 Eur/part
D&S cost:	5,00 Eur/part (40 Euro/KG)
Logistics cost:	Excluded
Total cost:	21,08 Eur/part

BASF We create chemistry | FORWARD AM Innovating Additive Manufacturing

How it Works for You

1 Do It Yourself

1. Order filament and D&S coupons from distributors

2. Print yourself at home or office

3. Send green parts to D&S network acc. to schedule

4. Receive finished parts and start using

2 Sculpteo

1. Order parts online @Sculpteo.com

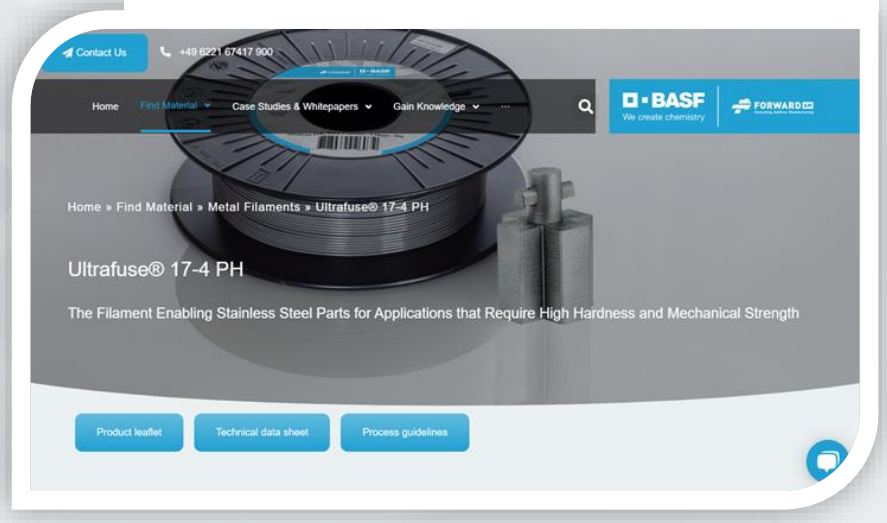
2. Receive finished parts in 2-3 weeks

sculpteo

BASF We create chemistry | FORWARD AM Innovating Additive Manufacturing

More Information on Metal FFF and Ultrafuse® Metal Filaments

Technical Documents on Website



Tutorial on Youtube

BASF We create chemistry | FORWARD AM Innovating Additive Manufacturing

THANK YOU!

BASF
We create chemistry

FORWARD AM
Innovating Additive Manufacturing