Info Session

REProMag
Resource Efficient Production of Magnets

Workshop in the frame of the World Resources Forum – 25 October 2017

Material Extrusion Additive Manufacturing for Production of Metal Parts

Dr. Joamin Gonzalez-Gutierrez

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Project funded by the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 636881

Motivation

- Additive manufacturing with metals usually done with Powder Bed Fusion
- PBF requires expensive equipment, expensive powder & post treatment

Direct Metal Laser Sintering

Source: EOS GmbH

Electron Beam Melting

Source: Arcam AB

*Price range: 5 000€ (plastics) up to 1.6 million € (metals)

*Source: Wohlers Report 2016: 3D printing and additive manufacturing state of the industry.

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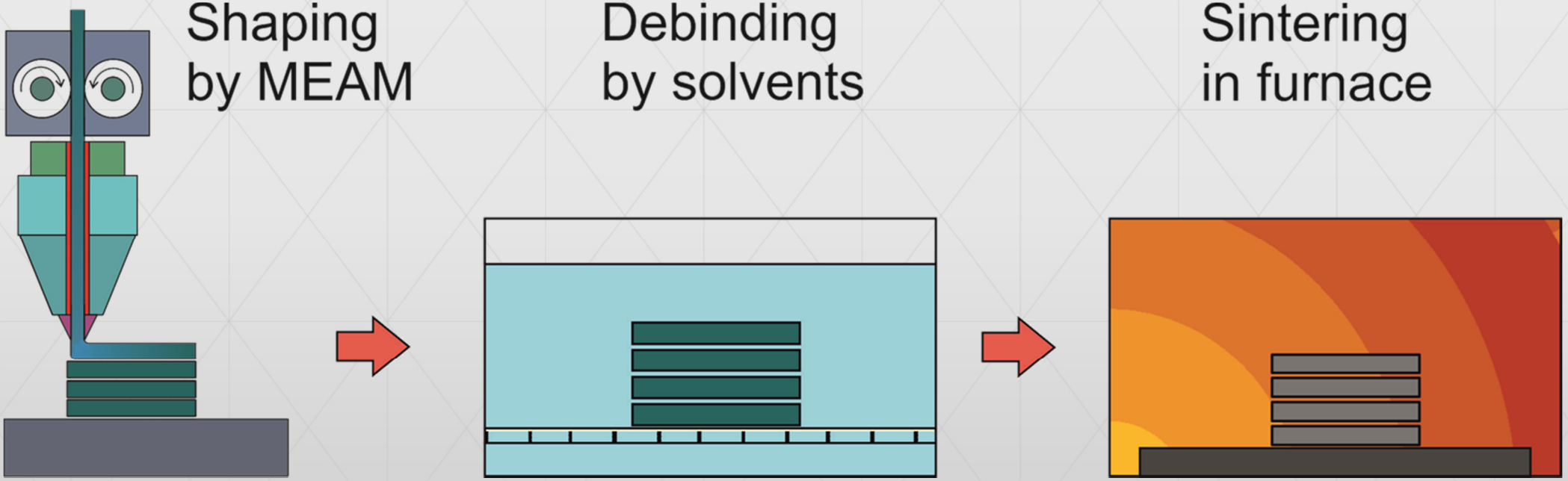
Alternative

- Shape Debind and Sinter (shaping by Material Extrusion AM)



*Price range: 500€ up to 215 000€ (Metal filled plastics)

*Source: Wohlers Report 2016: 3D printing and additive manufacturing state of the industry.

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Main challenge: Printing filaments

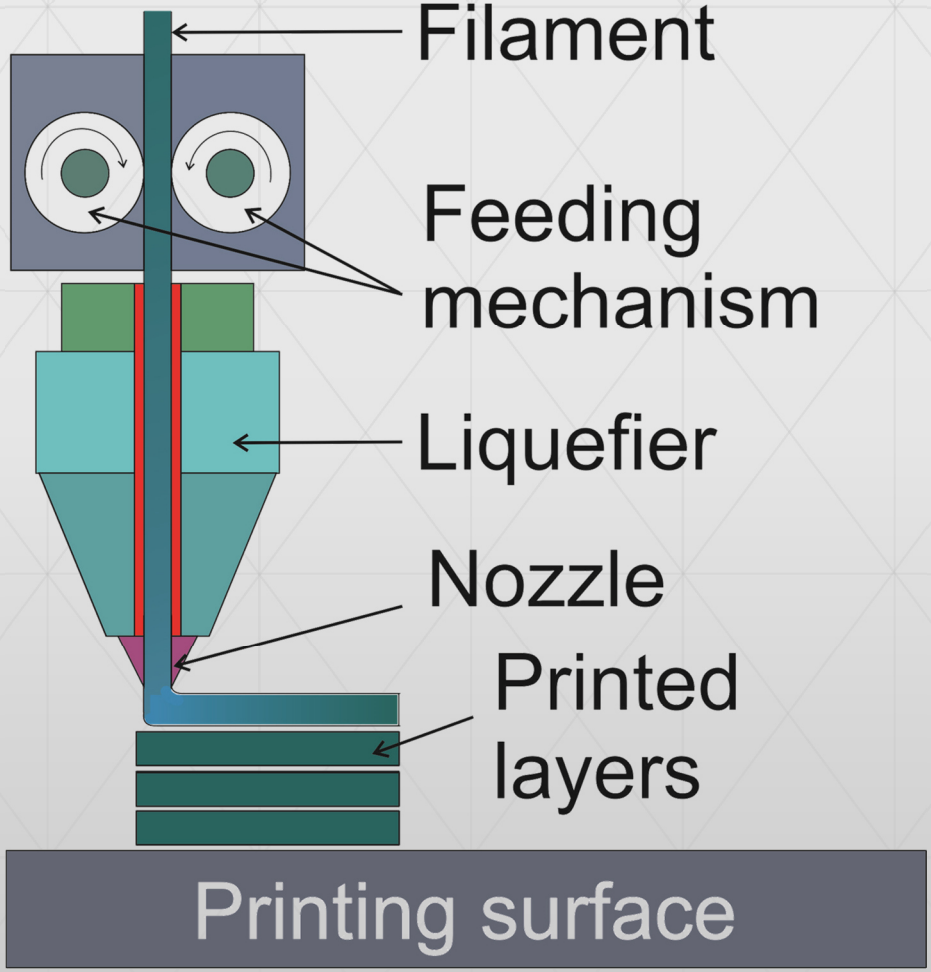
High content of powder (>50 vol%)

Flexibility for spooling

Transfer of force (strength, no buckling)

Thermoplastic extrusion (flows & solidifies)

Adhesion and bonding to printing surface and other layers



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Printable system

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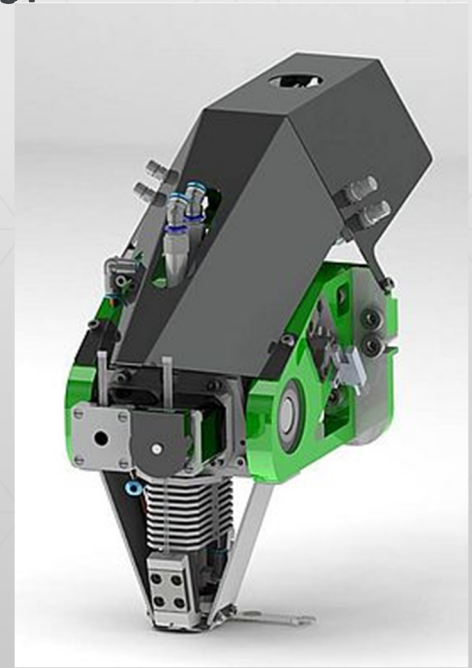
- New feedstock filament
  - Multicomponent binder
    - Main binder (elastomeric)
    - Backbone (polyolefin)
    - Compatibilizer
  - Metallic powders
    - Steel (316L, 17-4PH)
    - Titanium (Ti6Al4V)
    - Recycled magnets (NdFeB)
    - Copper (Cu 99.9)

- New printing head
  - Replace feeding rollers by feeding belts → Can push softer filaments!

HAGE
Automatisch im Vorteil



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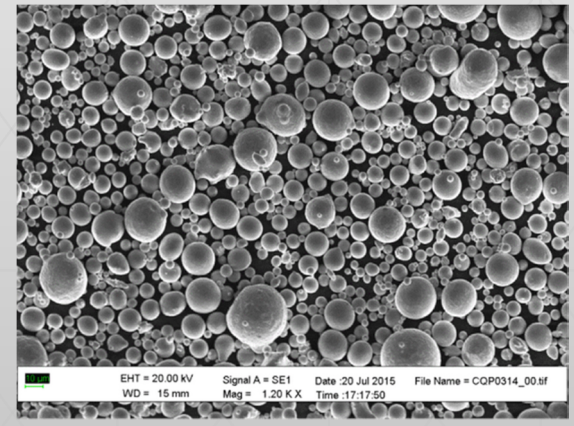
Powders PBF vs. SDS

- PBF
  - Powders have to flow easily
    - Spherical shape is needed
    - Set particle size distribution
    - Not too small or agglomerates
  - Price increases & limits materials

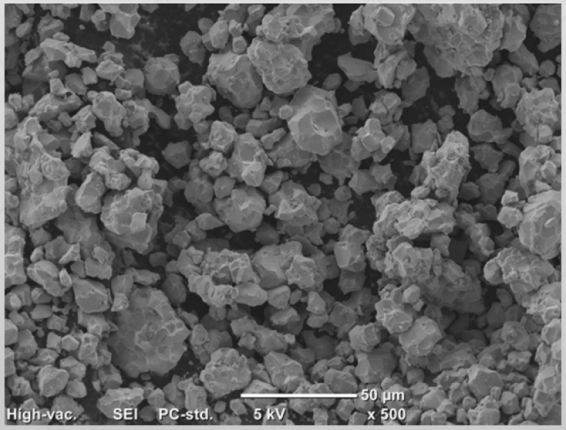
- SDS via MEAM
  - Powders flow with binder
    - Irregular shape is possible
    - Variable particle size distribution
    - Particles even in nano-sizes
  - Price reduces & more materials available

Gas atomized bronze



Source: rocking3dmetal.com

Recycled magnetic NdFeB



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Examples of printed parts

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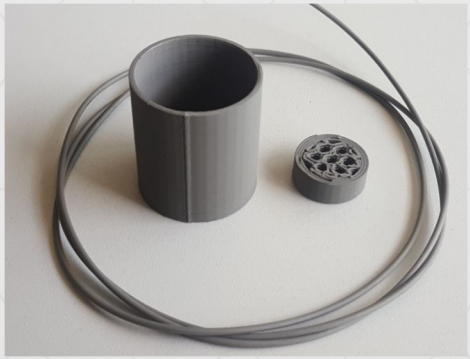
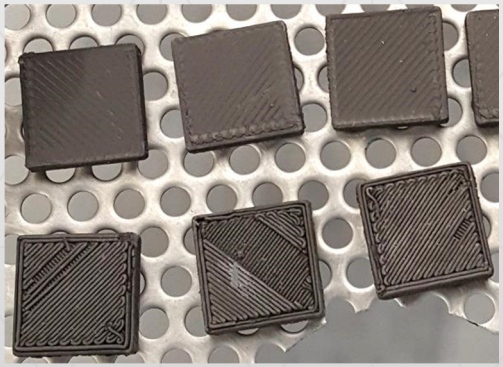
316 L

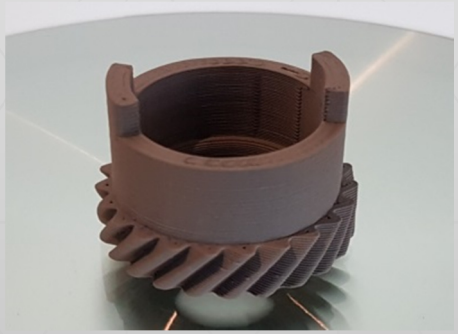


NdFeB



17-4PH

Ti6Al4V



Cu 99.9

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Debindable & sinterable system

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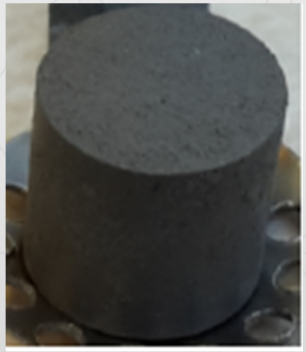
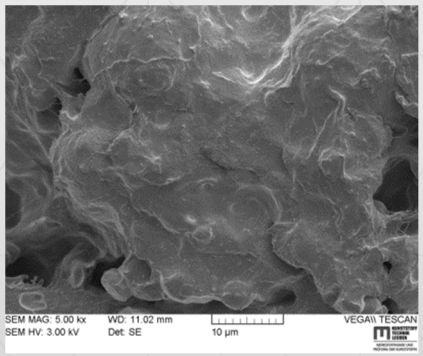
oBE Präzision

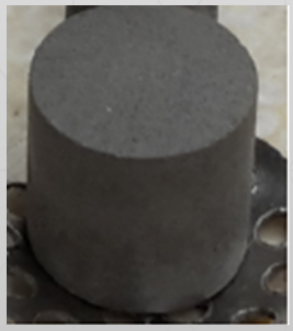
- Solvent debinding is possible
- Main binder component dissolves & part retains shape

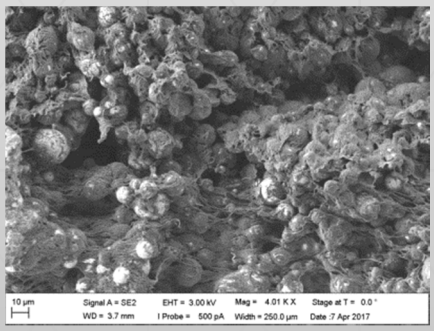
Before



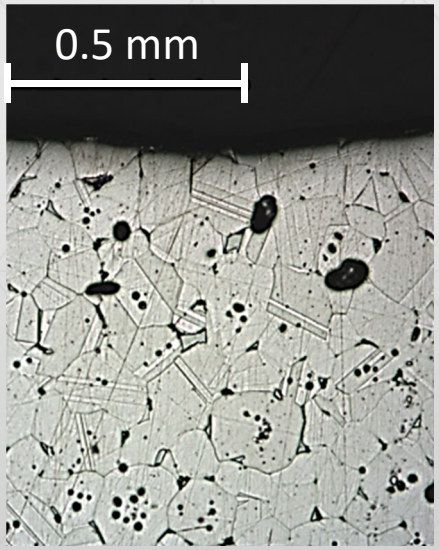


After





- Sintering is possible
- Backbone is eliminated & particles fused together



- Caution: part shrinks ~ 20%

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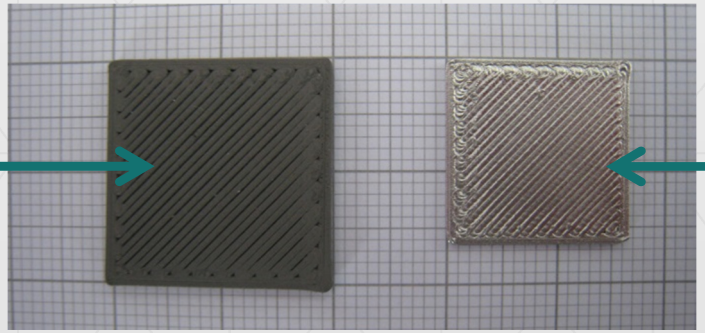
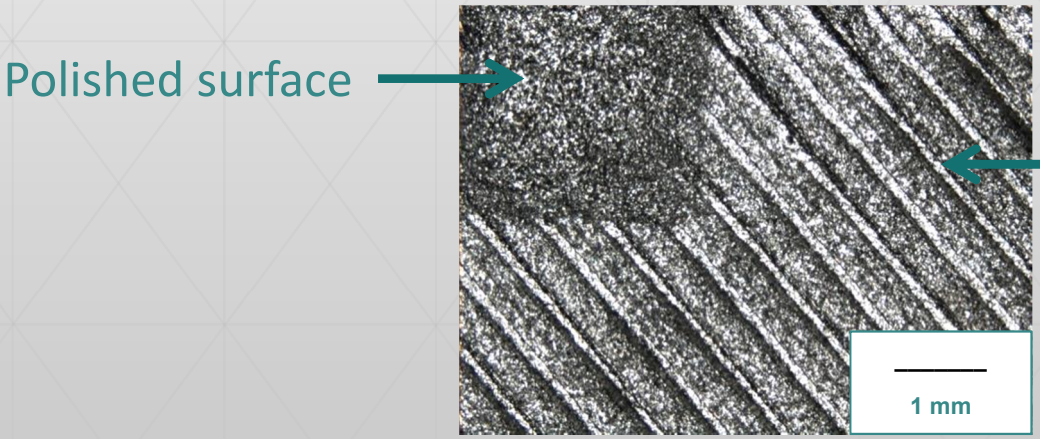
http://repromag-project.eu/

Improving surface quality

- Parts made by MEAM have a rough surface, but it is very easy to polish due to plastic binder





316L Sintered part

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Summary

- REProMag consortium has developed materials & equipment for producing metal parts via MEAM
- Printed parts can be debound in solvent & sinter to get solid pieces
- Polishing of printed part is very easy to improve surface quality
- SDS process with MEAM has been tested with steels, titanium, magnetic rare earths & copper.
- SDS with MEAM could be a economical alternative to PBF
  - Lower equipment price
  - Lower material cost
  - Less wasted material
  - Higher availability of materials

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Thank you

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