Economic additive manufacturing of high-performance plastic parts

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Content

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Fraunhofer Kunststoffzentrum Oberlausitz

- Part of Fraunhofer Institute for Machine Tools and Forming Technology IWU
- Interdisciplinary research team of 15 employees in the fields of plastics, textile, mechanical and production engineering
- Opening of the new technology center on the campus of HSZG in Zittau
- Mission: Applied R&D for industry in the triangle region D / CZ / PL

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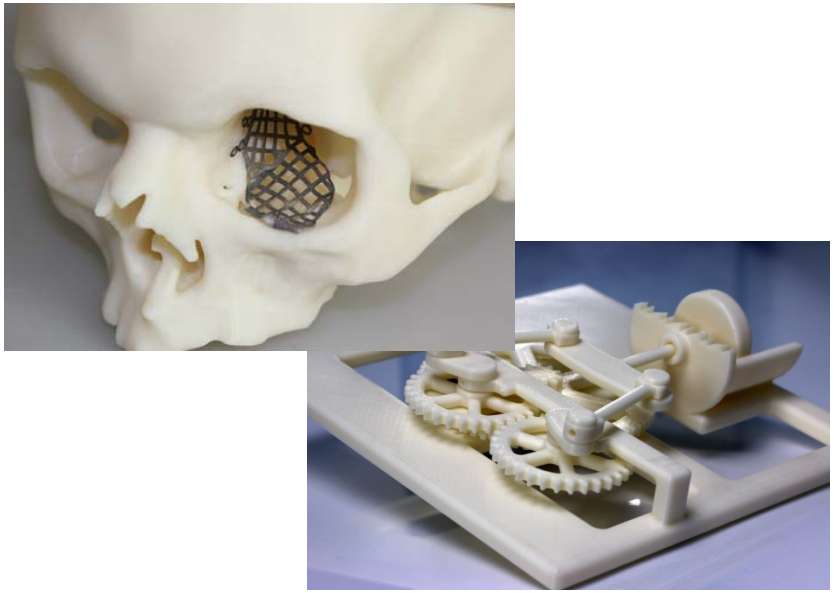
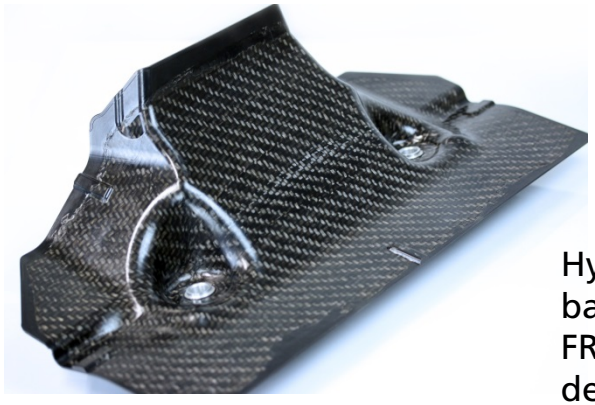
Fields of research

- Development of new applications using additive manufacturing
- Increasing efficiency in additive manufacturing through new production concepts
- Development of modified plastics for additive manufacturing to open up new applications
- Research in large-scale industrial technologies for thermoset and thermoplastic fiber composites
- Design and FEM calculation of complex and highly loaded lightweight composite parts
- Manufacturing prototypes made of plastics and composites





Hybrid automotive battery carrier in FRP lightweight design

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Research facilities

Additive manufacturing

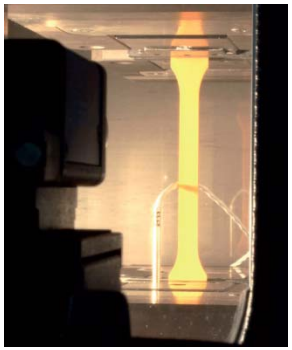
- FDM unit, Fortus 900mc by Stratasys
- LS unit, sPro 60 by 3D-Systems
- Robot supported FDM unit
- Blasting cubicle

Composite technologies

- Hot press with preheating station
- High-pressure RTM unit
- Plastics extruder
- Handling robot

Testing and analysis

- Static & dynamic testing unit with climatic chamber
- 3D digital scanner (mobile device by GOM)
- Digital microscope with 3D surface scanner
- Further test labs at HSZG



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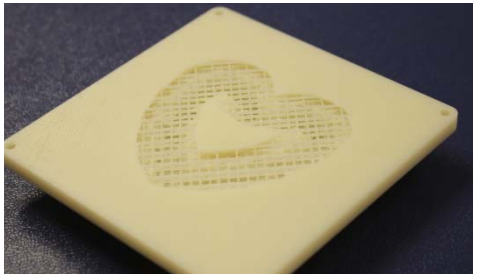
Selected projects: Efficiency in additive manufacturing

Efficient tooling concepts for the paper pulp process

- Target/ Innovation
  - Additive manufacturing of function integrated paper pulp molds
  - Increased dimensional stability and reduction of process times
- Research focus
  - Process concepts and development of mold segments and plant engineering
  - Experimental verification of the method and mold subsystems
  - Laboratory production unit for precision molded pulp demonstrators
- Application / Industrial sector
  - Packaging, transport, floristry

Pulp molding tool (front)



Pulp molding tool (rear)

Pulp molded part

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Selected projects: Efficiency in additive manufacturing

Flame-retardant LS material by means of functionalized glass foam

- Target/Innovation
  - Cost-efficient LS powder with flame-retardant properties
  - Higher strength and stiffness due to reinforcements
  - Halogen- and phosphate-free
- Research focus
  - Development of mixing concepts under consideration of fire resistance
  - Adjusting process parameters for effective manufacturing of functional and flame-resistant plastic parts
  - Production of glass foam and comminution to powder of different fractions
- Application / Industrial sector
  - Aviation, railway, automotive, electronics, exhibition construction

3D-printed air duct

citim

TROVOtech
functional inorganic additives

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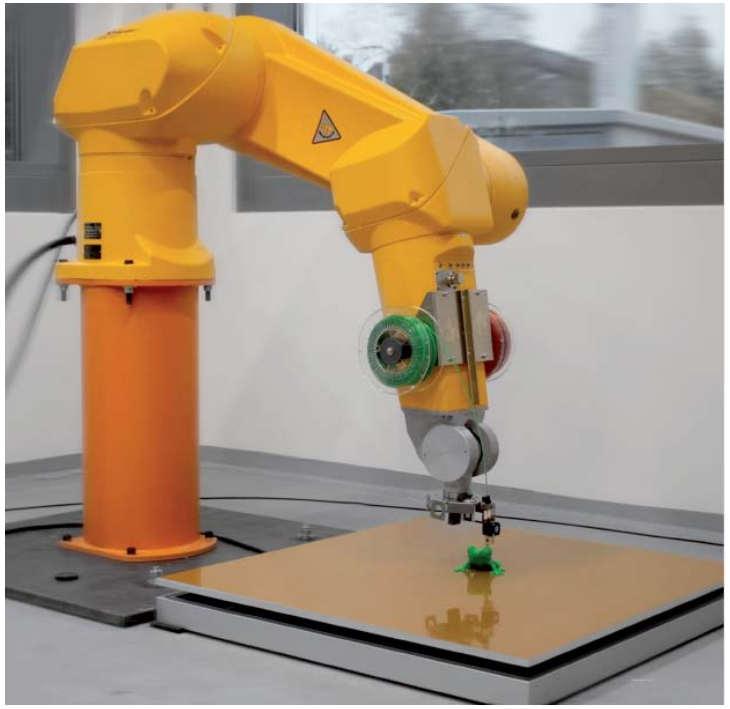
Selected projects: Efficiency in additive manufacturing

Development of a flexible pilot plant for the efficient additive manufacturing of large-sized plastic parts

Targets / Innovation

- Flexible production of complex, large-sized plastic parts
- Increase of the production speed with help of variable printheads
- Using the six axis for the part production on existing and non-planar surfaces
- High variance of process parameters
- Production of hybrid structurs with different plastics
- Innovative tempering concepts for shrinkage free manufacturing



FDM pilot plant

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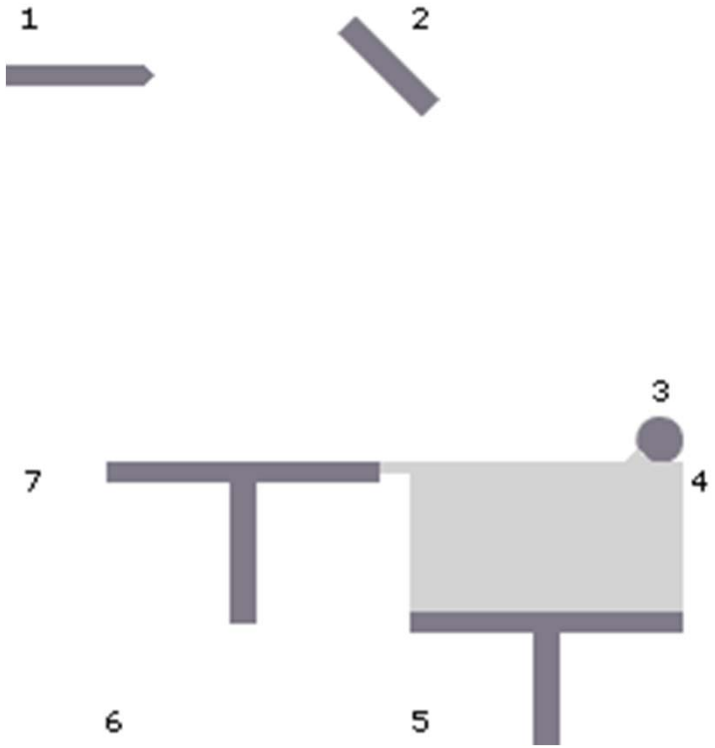
Economical LS-Materials with magnificent properties

Process Lasersintering



1 Laser

2 Mirror

3 Roller

4 Powder

5 Powderchamber

6 Buildenvelope

7 Part

[1zu1 Prototypen GmbH & Co KG]

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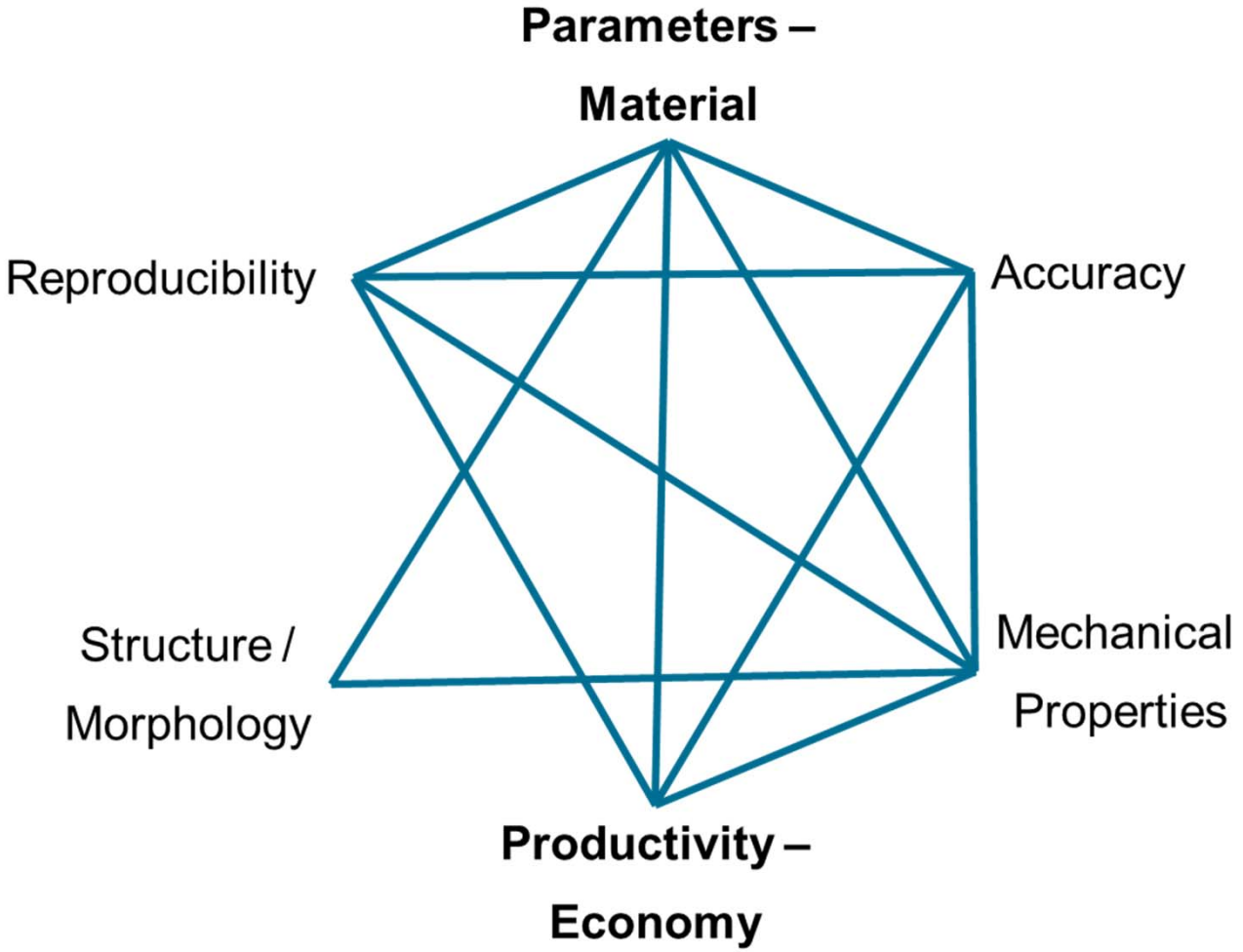
Economical LS-Materials with magnificent properties

Optimizing SLS-Materials



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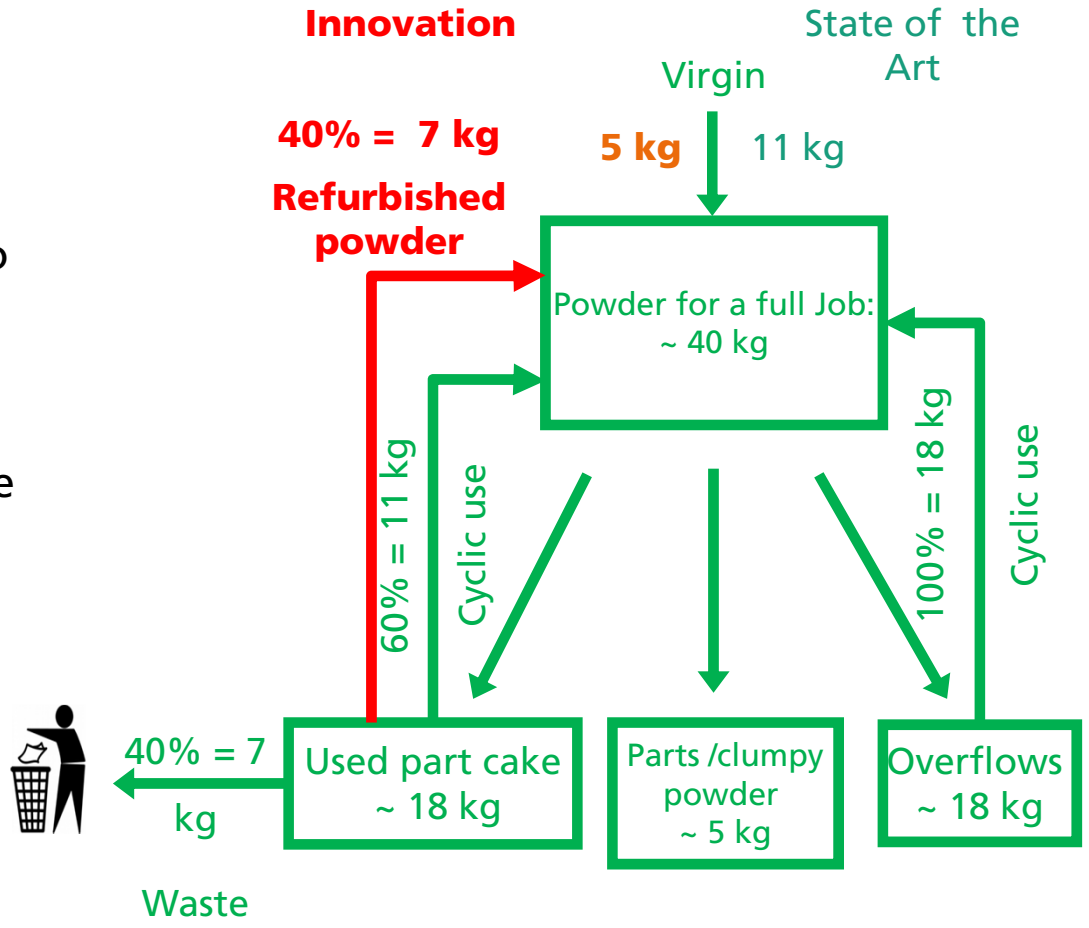
Economical LS-Materials with magnificent properties

Material efficiency

- Significant amount of used powder can not be used again due to aging → DISPOSAL
- A machine working Ø 100 h/ week causes up to 1.800 kg waste
  → over 52 T€ per year unused potential
- Refurbished powder can be re-used to reduce disposal completely
  - → Higher Efficiency
  - → Reducing waste
  - → Creating a closed material loop

Example: Vanguard / sPro 60 with Standard PA12-Powder



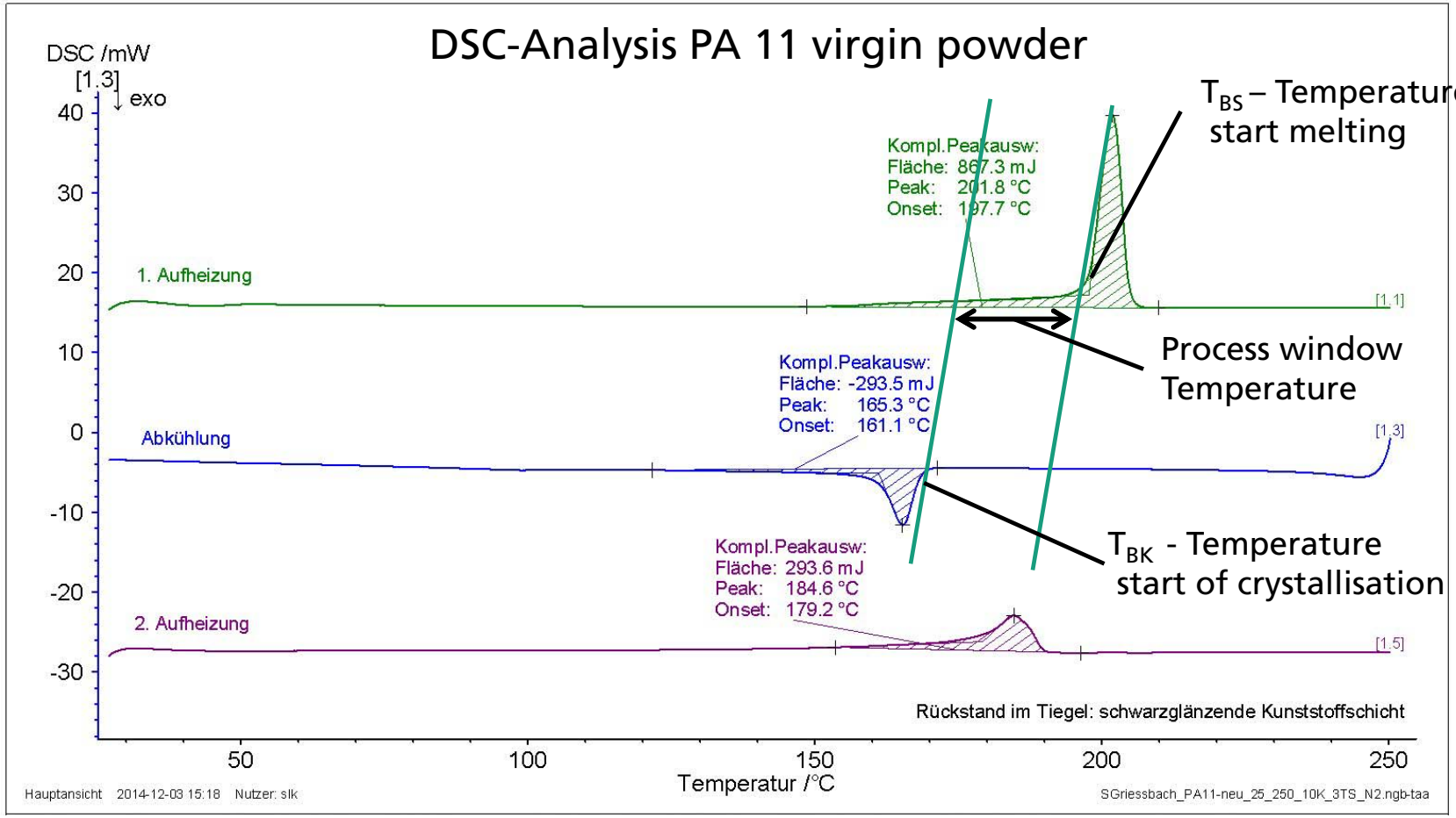
Economical LS-Materials with magnificent properties

Material efficiency

- Material is processed mechanically
- Higher efficiency
- Less waste – environmental sustainability
- Improved or even completly new mechanically properties

Economical LS-Materials with magnificent properties

Comparison virgin – refurbished powder



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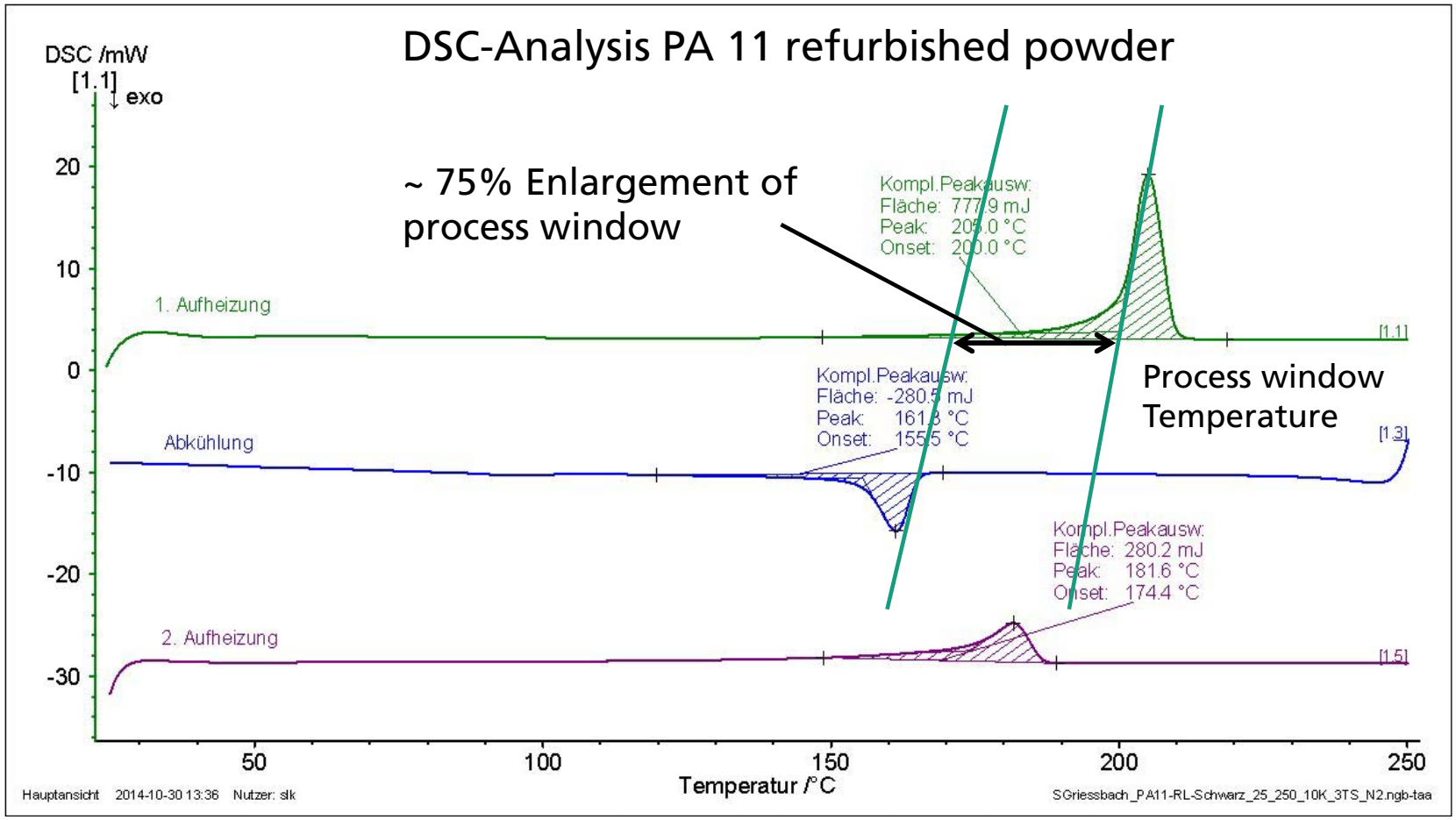
Economical LS-Materials with magnificent properties

Comparison virgin – refurbished powder



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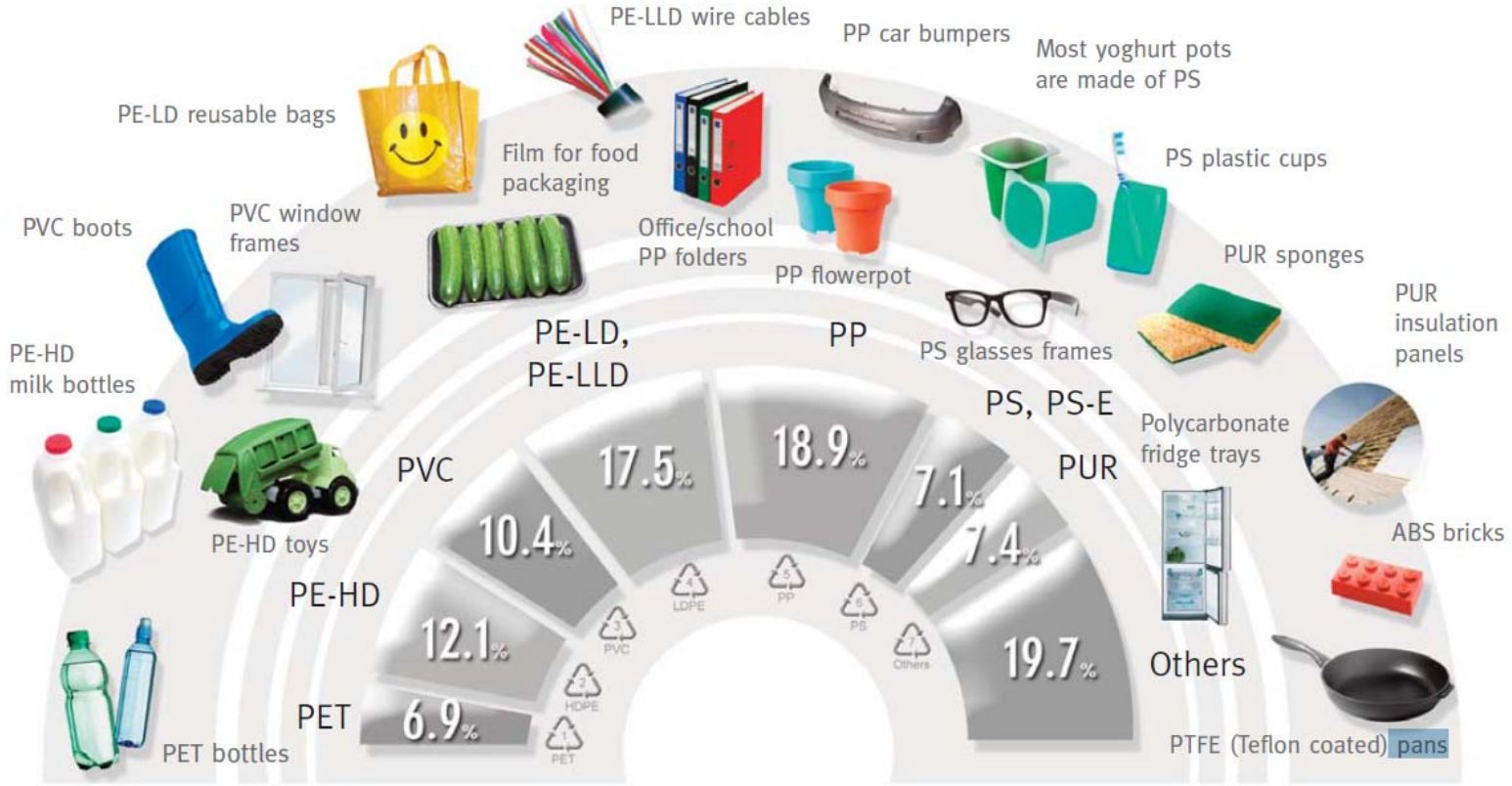
Economical LS-Materials with magnificent properties

Material improvement

PE & PP are most used plastics



Souce: PEMRG

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Mechanical properties molded PP/PE compared with sintered PA-Materials

Polypropylene (PP)

	Density	Tensile strength	Young Modulus
Units	g/cm³	N/mm² (psi)	N/mm² (ksi)
Value	0,90 – 0,91	20 – 40 (2,900-5,800)	800 – 1,600 (115-230)

Polyethylene (PE-HD)

	Density	Tensile strength	Young Modulus
Units	g/cm³	N/mm² (psi)	N/mm² (ksi)
Value	0,94 - 0,97	15 – 30 (2,200-4,400)	600 – 1,400 (90-200)

Polyethylene (PE-LD)

	Density	Tensile strength	Young Modulus
Units	g/cm³	N/mm² (psi)	N/mm² (ksi)
Value	0,91 - 0,93	10 – 25 (1,500-3,500)	200 - 600 (30-90)

DuraForm EX (PA 11)

	Density	Tensile strength	Young Modulus
Units	g/cm³	N/mm² (psi)	N/mm² (ksi)
Value (3D)	1,01	48 (6,961)	1,517 (220)
Value (own)	1,00-1,04	48-52 (6,900-7,500)	1.500 – 1600 (220-235)

DuraForm PA (PA 12)

	Density	Tensile strength	Young Modulus
Units	g/cm³	N/mm² (psi)	N/mm² (ksi)
Value (3D)	1,00	43 (6,237)	1,586 (230)
Value (own)	0,95 – 1,02	45-52 (6,500-7,500)	1,600 – 1,900 (230-280)

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Economical LS-Materials with magnificent properties

Working with refurbished PA 11

- Available on any DTM/3D (HiQ) machines

Either:

Getting 100% PA11-performance

OR:

- By using refined PA11 material Young Modulus can be adjusted with even good Values for EatB (>20%)

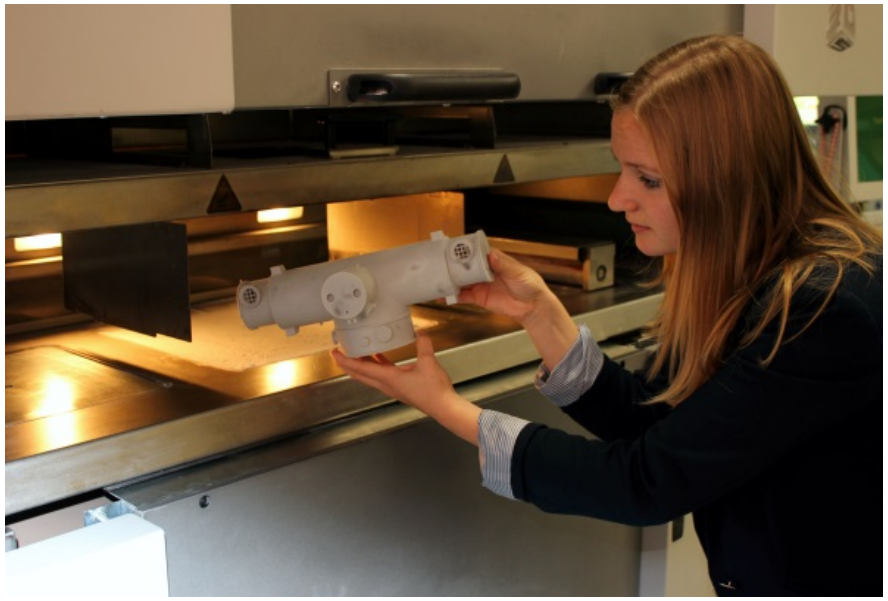
	Density	Tensile strength	Young Modulus
Units	g/cm³	N/mm² (psi)	N/mm² (ksi)
PP-like	0.96 – 0.99	30 – 35 (4,300 – 5,100)	1,000 – 1,200 (145 –175)
PE-like	0.90 – 0.93	20 – 25 (2,900 – 3,600)	600 – 800 (90 –120)

Economical LS-Materials with magnificent properties

Conclusion

- Significant higher efficiency by using refined LS-powder
- Improved mechanical properties
- Less influences by variation of raw powder – higher repeatability
- Less fairy frost due to less virgin powder – less service – less down time
- Enlarging the market through a wide range of mechanical properties

Thank you for your attention!



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