FFD Freudenberg Forschungsdienste KG

Arbeitskreis KING Würzburg

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Generative Manufacturing Methods
Turning new product ideas quickly into marketable products

FHWS

Hochschule für angewandte Wissenschaften
Fachhochschule Würzburg-Schweinfurt

Freudenberg Forschungsdienste KG
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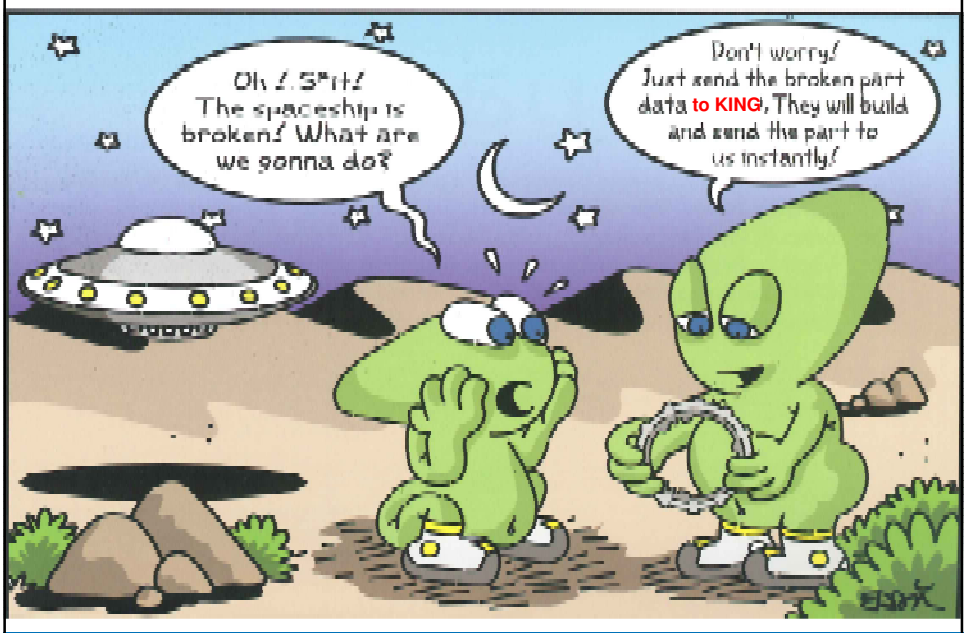

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We are part of the Freudenberg Group

Corporate Headquarters:

Freudenberg und Co.
Kommanditgesellschaft
69465 Weinheim
Germany

www.freudenberg.de

Employees: ca. 32700
Turnover: ca. 5.05 Bil. €
(Figures of 2008)

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Organisation of the Freudenberg Group / Turnover 2008

Parent Company: Freudenberg & Co.

Business Area	Seals and Vibration Control Technology Business Area	Nonwovens Business Area	Household Products Business Area	Specialities and Others Business Area
Business Groups	Seals and Vibration Control Technology Europe 1191 Mio € Seals and Vibration Control Technology America 841 Mio € Seals and Vibration Control Technology China 138 Mio € Vibracoustic Europe 496 Mio € Burgmann Industries 449 Mio €	Nonwovens 778 Mio € Freudenberg Politex Nonwovens 219 Mio €	Household Products 656 Mio €	Chemical Specialities 512 Mio € Mechatronics 24 Mio € IT-Services 66 Mio € New Technologies 30 Mio € Division Service Support 91 Mio €

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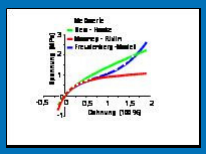
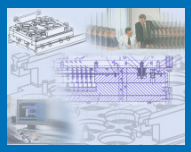
Fields of Activity

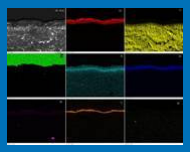
Polymers and Processing



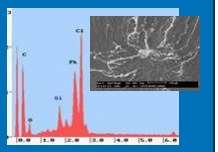
Physics and Simulation



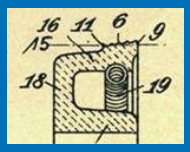
Technical Services



Chemistry and Interfaces



Material and Failure Analysis



Patents, Trade-marks, Information

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Rapid Prototyping

Goals

- fast and uncomplicated manufacturing of prototypes and models in the planning phase
- overview of desires and problems with the system
- Prototypes must almost have (near) series quality: mechanical properties, high accuracies (in all directions), good surface finish
- uncomplicated manufacturing of complex parts
- elimination of manual rework
- short construction period

Targets

- for early function tests
- technical discussions (e.g. manufacturing-specific realizations for series production)
- collision tests
- fitting space specification
- tools engineering
- Marketing tool in commercial discussions

Rapid Prototyping

Advantages

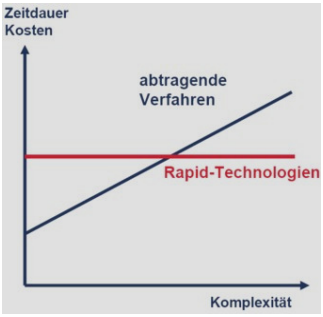
- fast recognition of problems in production environment (assembling tests)
- clearly faster and more economically than the conventional building of prototypes
  - the production of a 3D of part doesn't need tools

Disadvantages

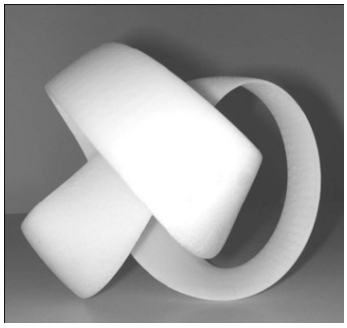
- reduced sizes of models and prototypes (for big parts)
- reduced accuracy (process-typical surface roughness)

Generative manufacturing methods

- Fast, economical and fully automatic manufacturing
- Costs depend only on the size of the part, not however on its complexity



standard vs. generativ



Exemple

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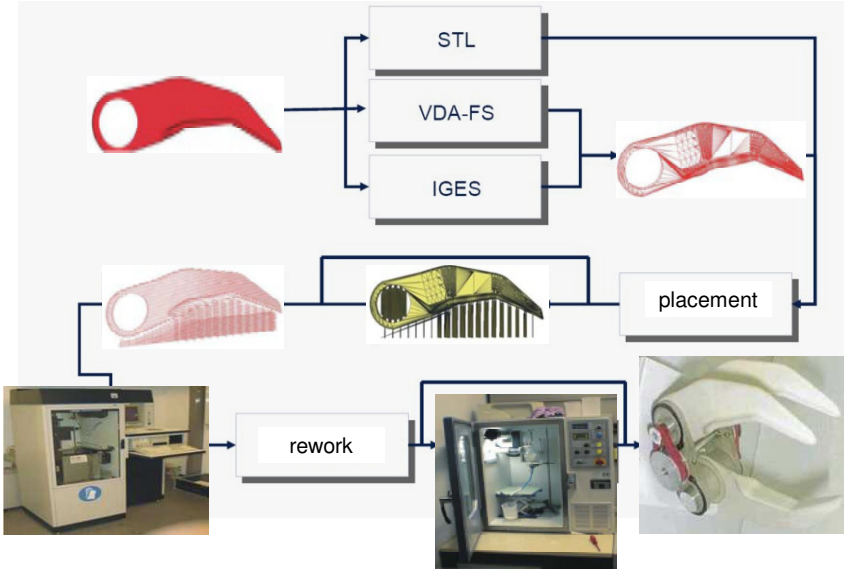
Generative manufacturing methods – way of solution



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Stereolithography (SLA)

history

- first RP-method on the world
- patented1984
- commercialization 1988 - 3D-Systems Inc.

process information

- polymerizing a liquid monomer by exposing it to light of a specific frequency

Citroën C3 in Stereolithographie (Maßstab 1:5), gestrichen und lackiert. *(Citroën C3 in stereolithography (scale 1/5), painted and lacquered)*

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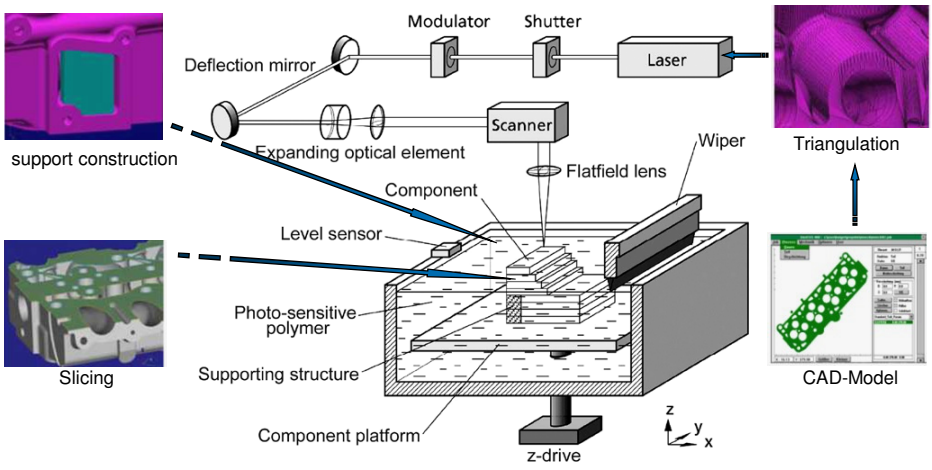
Stereolithography (SLA)



Schematic structure of the stereolithography process

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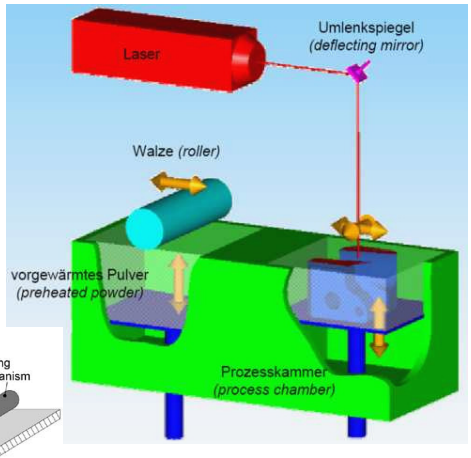
Selective Laser-Sintering (SLS)

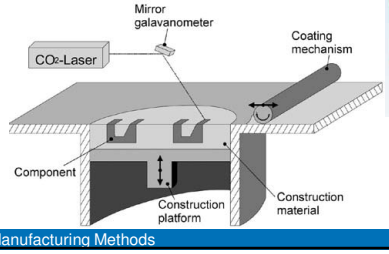
Process information

- Powder with grain sizes of 50 to 100 µm is used
- The grains are fused together in layers using a laser beam
- After solidifying, the grains bond to form a solid layer joined to the previous layer

Materials

- Thermoplastic materials (ABS, PA, PC, PS)
- Metals (Bronze-Nickel, Bronze-Stahl)
- Ceramics
- Metals/plastics (cooper-PA)





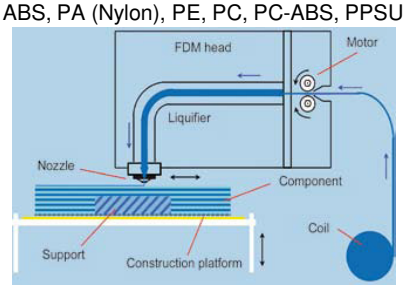
Fused Deposition Modeling (FDM)

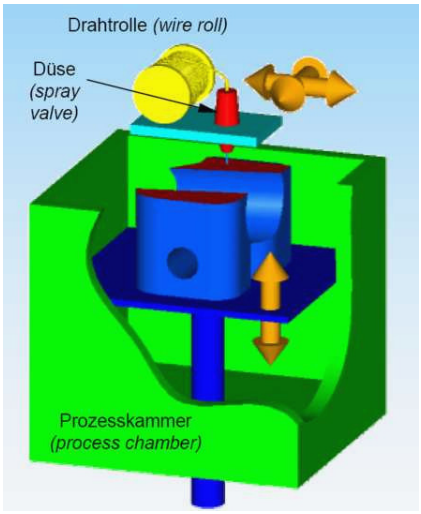
Process information

- models are generated from thermoplastic wire
- The semi-liquid thermoplastic material is applied as a new layer to the already existing structure and cools immediately.

Materials

- ABS, PA (Nylon), PE, PC, PC-ABS, PPSU





3D-Printer for soft and hard materials

- Volume of Parts: 500 x 400 x 200 mm
- Resolution x/y: 600 x 600 dpi
- Resolution z: 0.016 or 0.030 mm
- Materials: 61 to 85 Shore A

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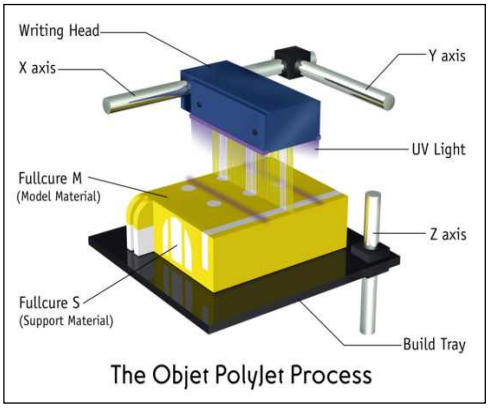
Objet technology

Overview



PolyJet© Technology
"From InkJet to PolyJet"

Layer thickness

only 16µm (0.016mm)

Connex 500
switchable 0.016 / 0.030 mm

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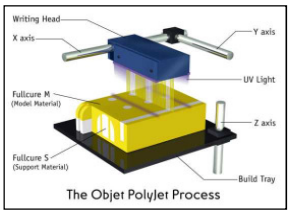
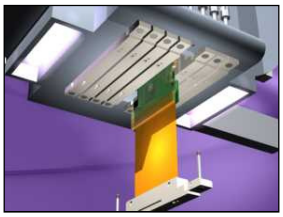
Processing Steps

Overview

1. Connex500



2. Technology
0.016/0.030mm thickness, UV-curing



3. Printing Head
768 valves

4. Material System

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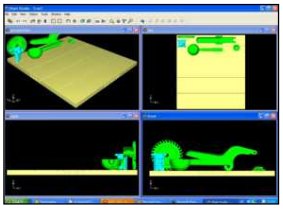
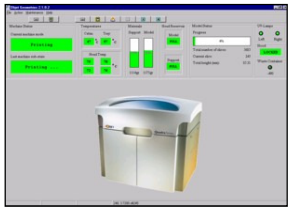
Processing Steps

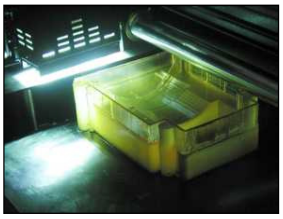
Overview



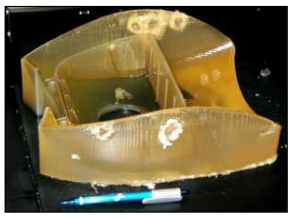
5. STL-Data



7. Material management system



7. Building process
„Z"-axis about 1cm/h



8. Final product with support material

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Parts overview

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Flexible Materials

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Movable prototypes

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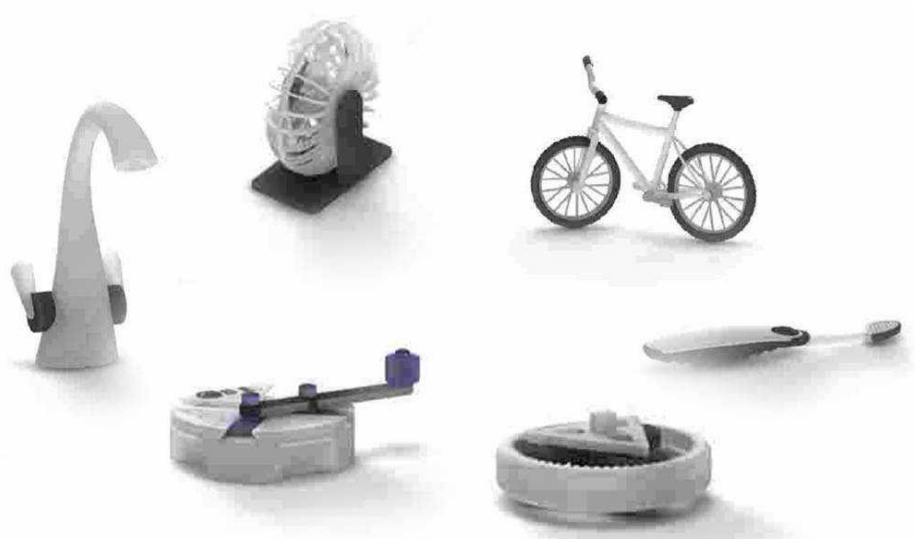
Material Combinations



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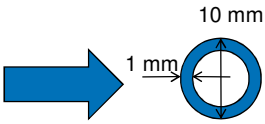
Basic information

- Tray size (X x Y x Z)
  - 500 x 400 x 200 mm
- Net build size (X x Ya x Z)
  - 490 x 390 x 200 mm
- Layer thickness (Z-axis)
  - Horizontal build layers down to 16-micron
- Build Resolution
  - X-axis: 600 dpi
  - Y-axis: 600 dpi
  - Z-axis: 1600 dpi
- Printing Modes
  - Digital Material (DM): 30-micron (0.001 inch)
  - High Quality (HQ): 16-micron (0.0006 inch)
  - High Speed (HS): 30-micron (0.001 inch)
- Accuracy
  - 0.1-0.3 mm (0.004-0.01 inch) typical (accuracy varies according to geometry, part orientation and print size)



30.000 parts

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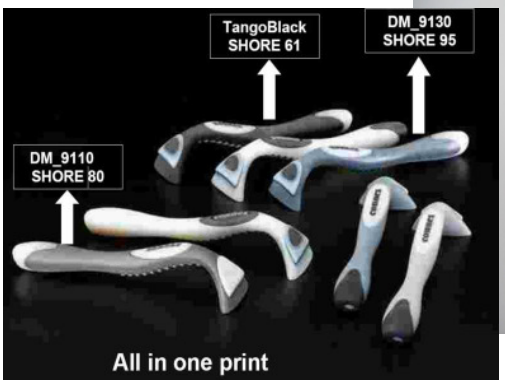
Connex500 Shore-hardness options



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Summary

- Generative manufacturing methods – important tool for the development and marketing phase
- Short manufacturing times– accelerated development
  - **from 1 hour up to one week**
- Low prices

- High number for different technologies – Adjustment at part requirements
  - mechanical
  - thermal
  - chemical

- high part complexity
  - large choice of materials - from soft to hard
  - material combinations
  - movable systems
- Models as basic- form for further procedures of building of prototypes usable
  - “negative” form for vacuum casting, ceramic(s) casting

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Danke fürs Zuhören!

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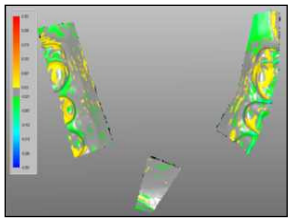
Processing Steps

Overview

9. Water-jet cleaning
60 bar pressure

10. Water-jet cleaning

11. Final Part

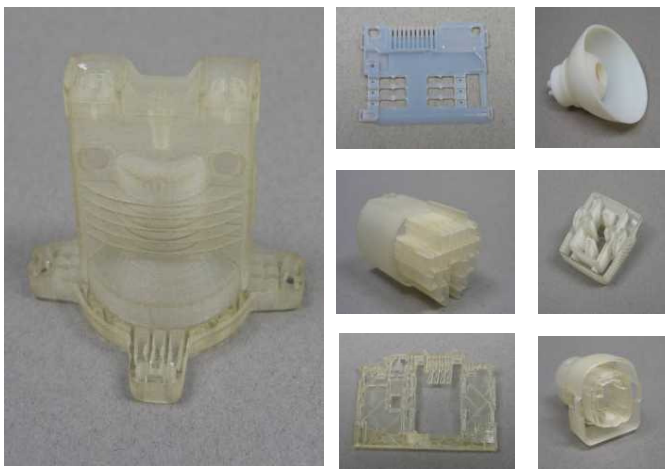


12. Accuracy
between 0.05 und 0.1 mm

Example: BMW-MINI

Mit freundlicher Unterstützung: Beuttenmüller GmbH

Electronic



Mechanical constructions