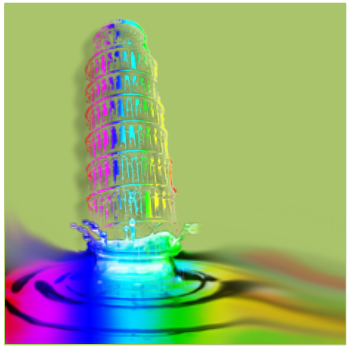
Laser Sintering

Micro e Nano Sistemi



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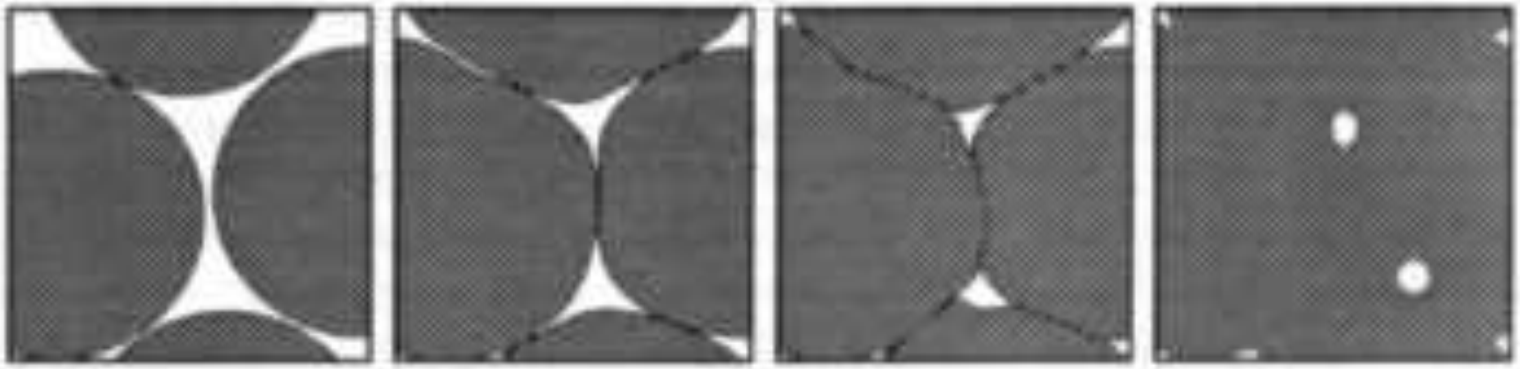
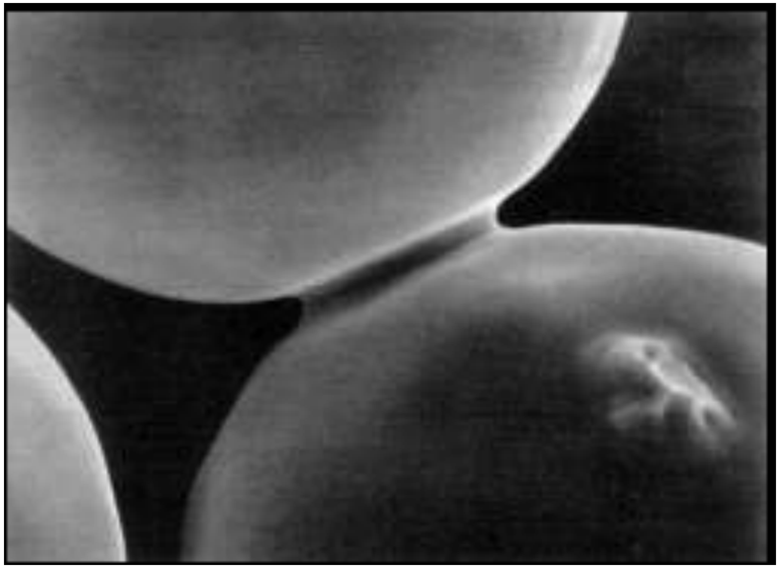
Sinterizzazione





Sinterizzazione

- **Sintering:**
- bonding of the metal, ceramic or plastic powders together when heated to temperatures in excess of approxiamately half the absolute melting temperature.
- In the industry, sintering is mainly used for metal and ceramic parts (Powder Matallurgy).
- After pressing (compaction) of the powder inside mold for deforming into high densities, while providing the shape and dimensional control, the compacted parts are then sintered for achieving bonding of the powders metallurgically.

Sintering in Rapid Prototyping

- Sintering process used in Rapid Prototyping differs from the Powder Metallurgy, such as:
  - Plastic based powders, in additon to metal powders.
  - Local sintering, not overall sintering.
  - Very short sintering period.
- Laser (heat source) is exposed to sections to be sintered for a very short time. Hard to achive an ideal sintering.
- In some applications, for achieving the ideal sintering, the finished parts are heated in a seperate sintering owen.

Selective Laser Sintering (SLS)

- Invented by Carl Deckard during his Phd. studies in Texas University in 1987.
- Offers the key advantage of making functional parts in essentially final materials.
- The system is mechanically more complex than stereolithography and most other technologies.
- A variety of thermoplastic materials such as nylon, glass filled nylon, polyamide and polystyrene are available. The method has also been extended to provide direct fabrication of metal and ceramic objects and tools.

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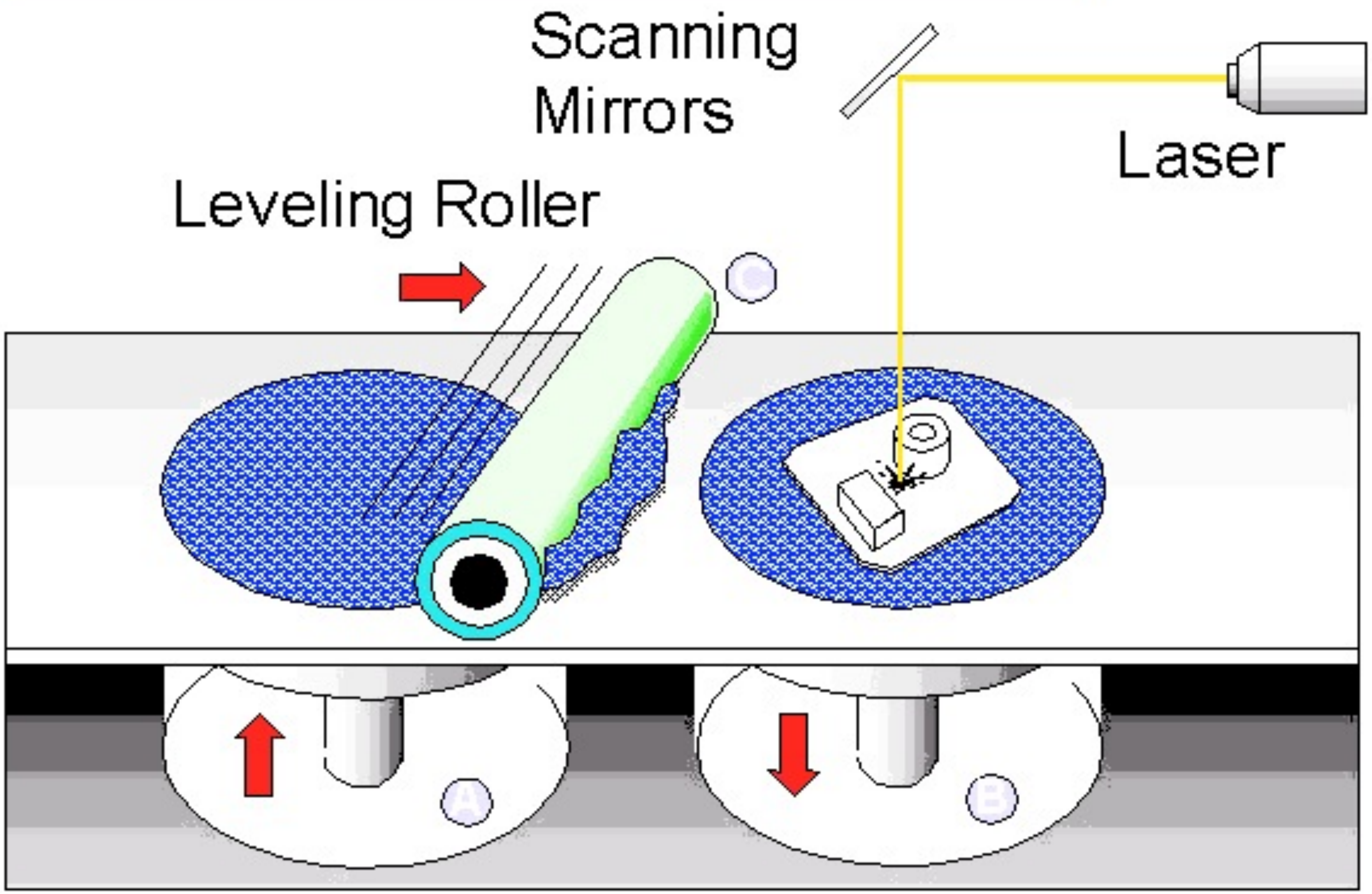
SLS samples

Selective Laser Sintering



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Selective-Laser-Sintering

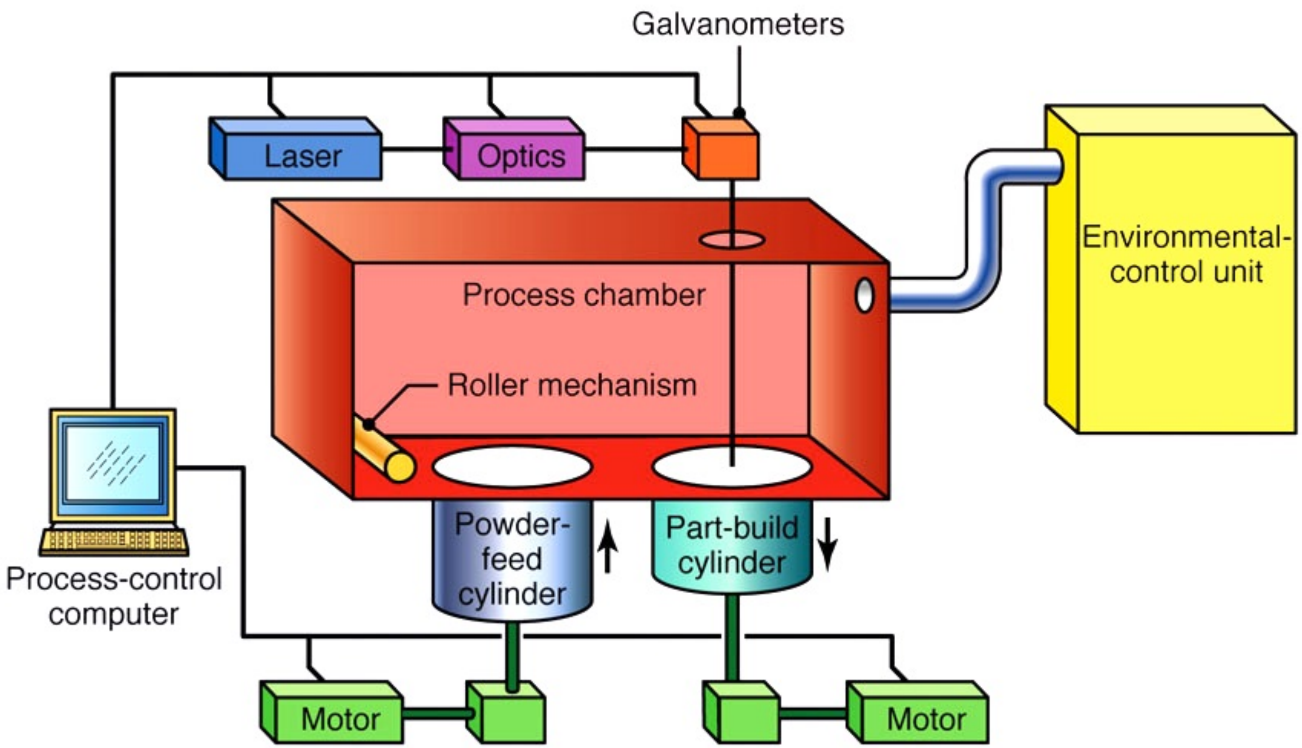
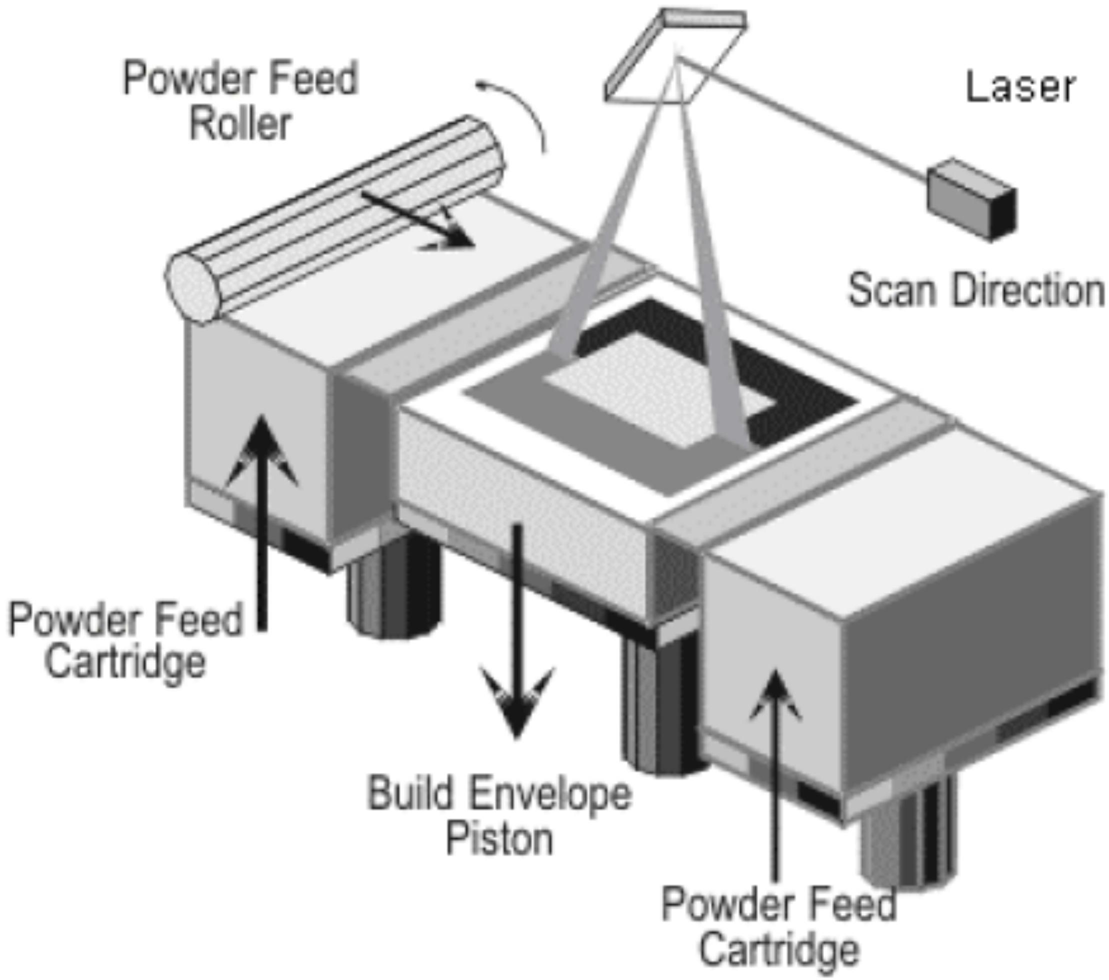
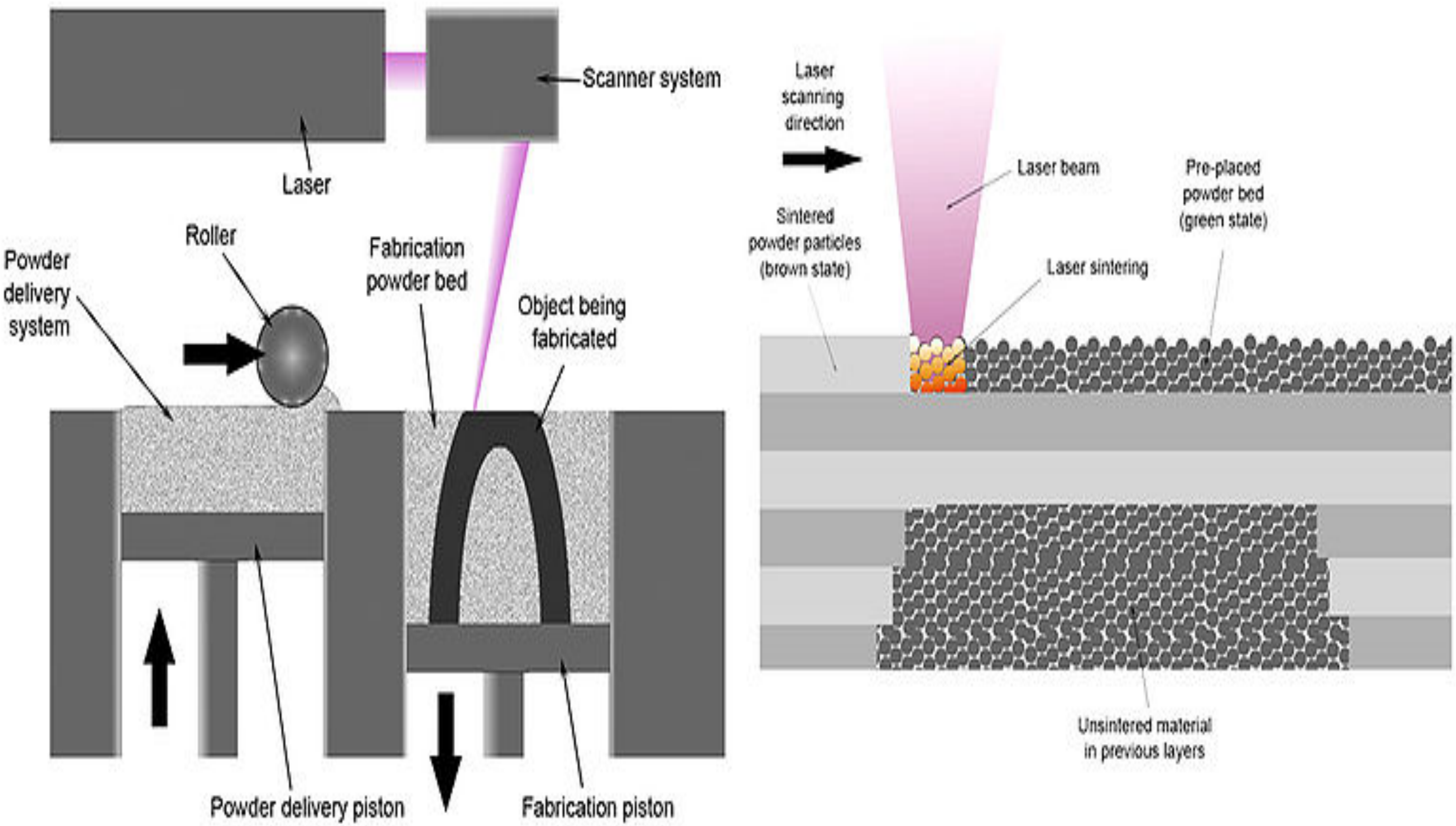


Figure 20.7 Schematic illustration of the selective-laser-sintering process. *Source*: After C. Deckard and P. F. McClure.
Manufacturing, Engineering & Technology, Fifth Edition, by Serope Kalpakjian and Steven R. Schmid.

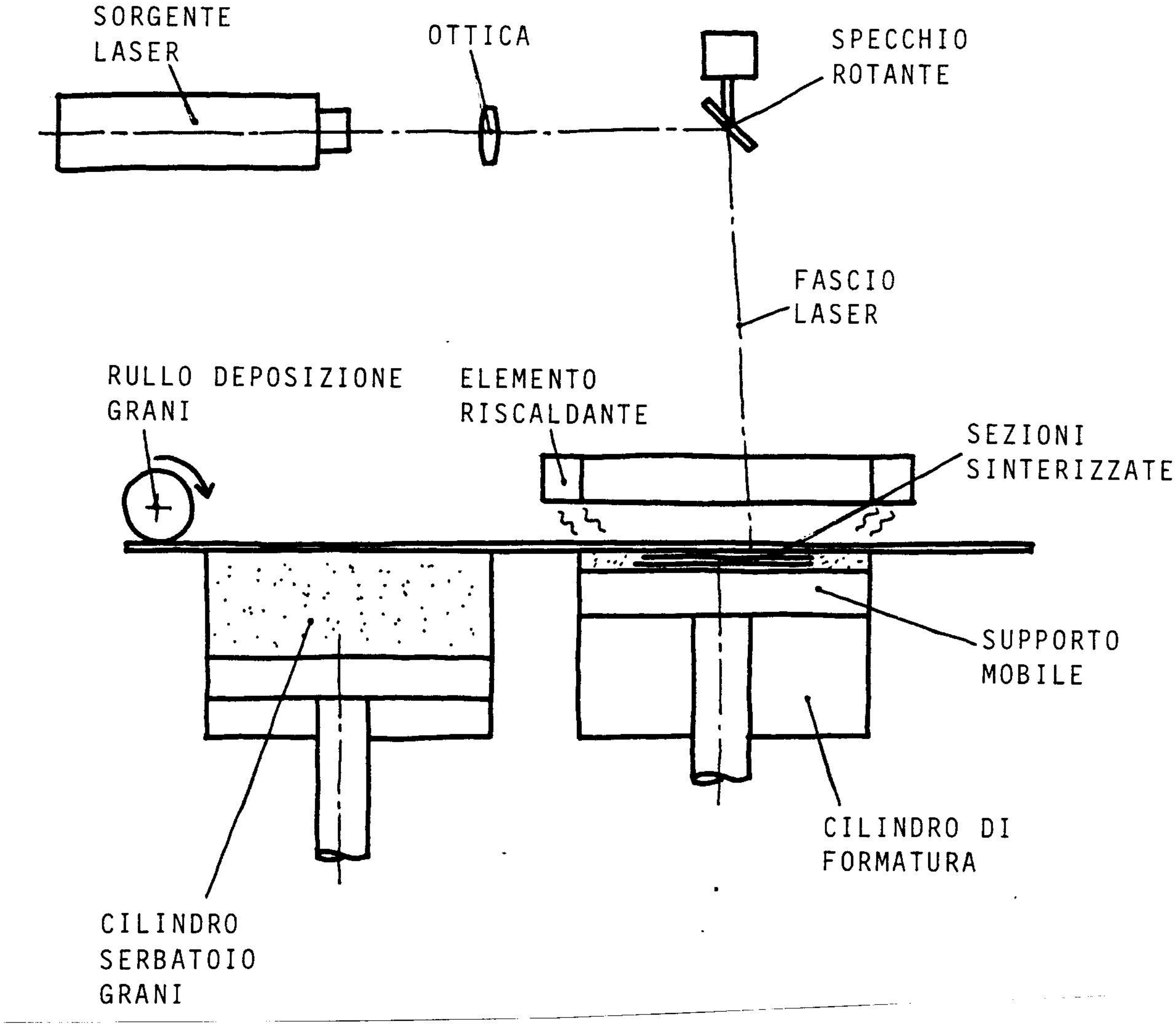
Selective Laser Sintering



Selective Laser Sintering



Selective Laser Sintering



Selective Laser Sintering

Process:

1) Laser beam is traced over the surface the tightly compacted powder to selectively melt and bond it to form a layer of the object.

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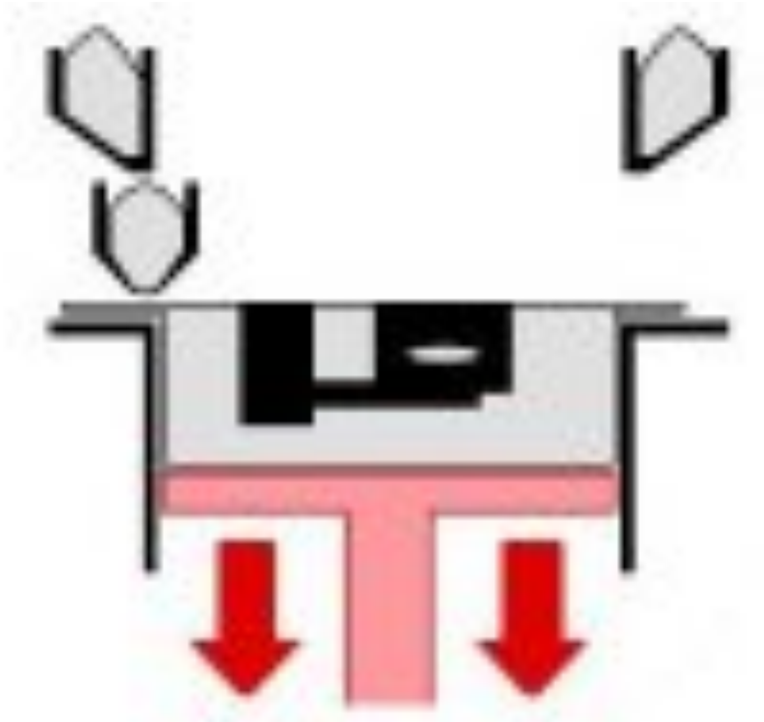
Selective Laser Sintering

Process:

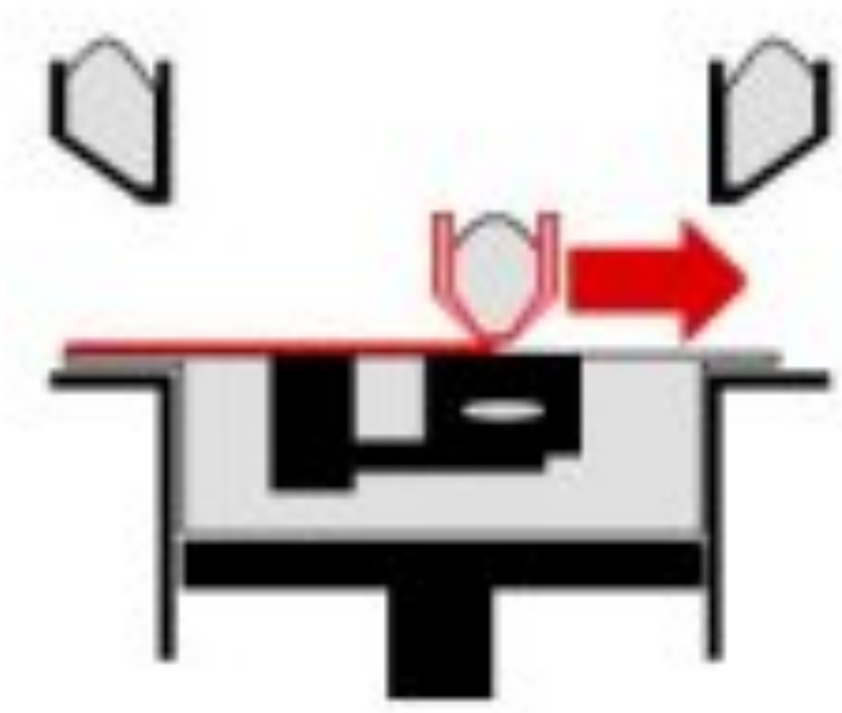
2) Platform is lovered down one object layer thickness to accommodate the new layer of powder



Selective Laser Sintering

Process:

3) A new layer of powder is coated on the surface of the build chamber.

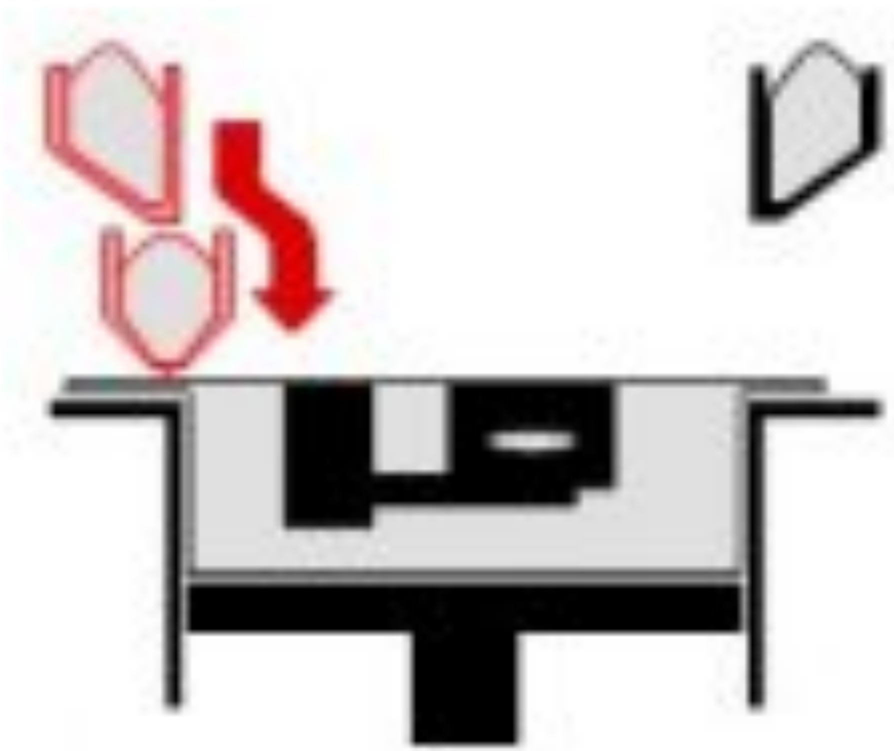


Selective Laser Sintering

Process:

4) The powder is supplied from the powder bins to the recoater.

This process is repeated until the entire object is fabricated.



Selective Laser Sintering

- The fabrication chamber is maintained at a temperature just below the melting point of the powder
- Heat from the laser need only elevate the temperature slightly to cause sintering. This greatly speeds up the process;
- No supports are required with this method since overhangs and undercuts are supported by the solid powder bed;
- Surface finishes and accuracy are not quite as good as with stereolithography, but material properties can be quite close to those of the intrinsic materials

Materials

- Polymers
  - nylon, ABS, PVC, and polystyrene,
  - nylon/polycarbonate powders are health hazards (dangerous to breathe).
  - glass-filled or with other fillers
  - metals encapsulated in plastic.
- Metals
  - low melting metal alloys of nickel bronze, steel, titanium, alloy mixtures, and composites
- Green sand (for sand casting).

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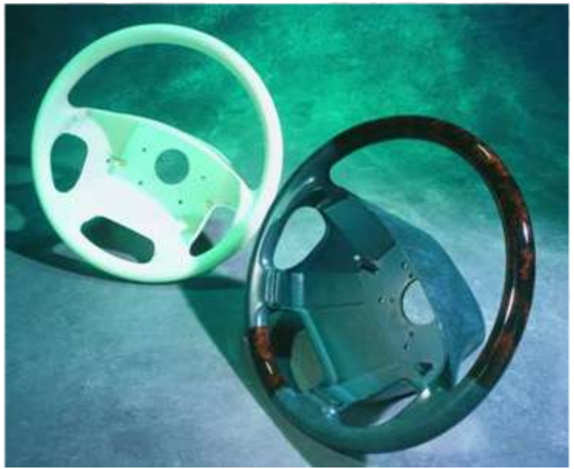
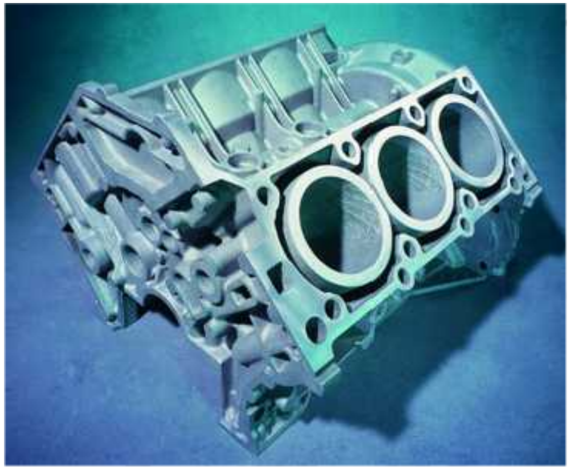
Plastic Laser Sintering

- For direct manufacture of styling models, functional prototypes, patterns for plaster, investment and vacuum casting, for end products and spare parts.

- Volvo Steering Wheel
- Engine Block Pattern
- Plaster Invest. Pattern

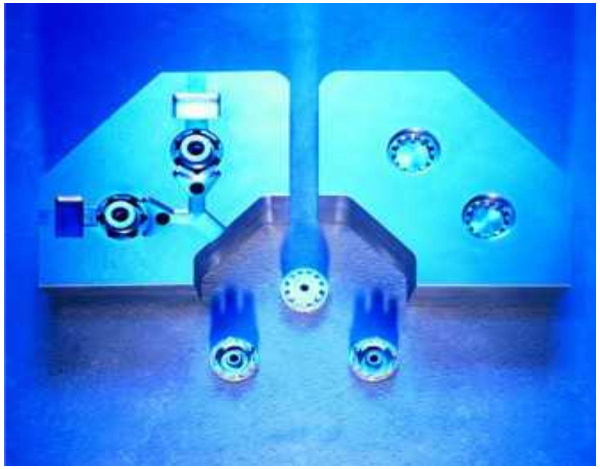


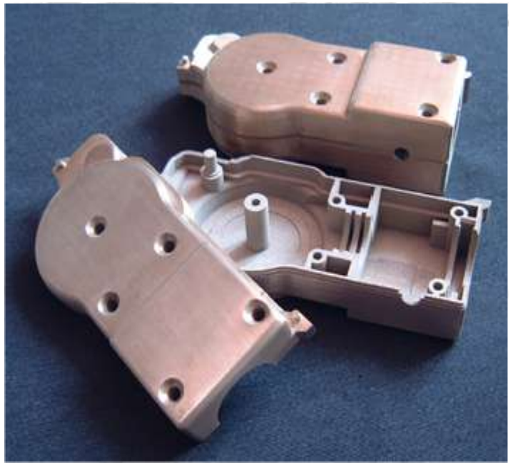


Metal Laser Sintering

- For direct production of tooling, including for plastic injection molding, metal die casting, sheet metal forming as well as metal parts, directly from steel based and other metal powders.

- A gear for Volvo Corp.
- Die Cast Parts (500 Al parts produced)
- Motor Housing





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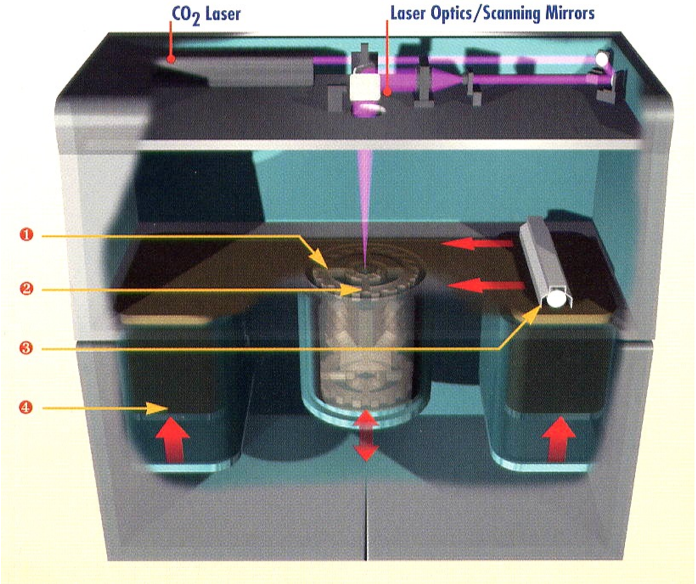
Sand Laser Sintering

- Laser Sintering System for direct, boxless manufacture of sand cores and moulds for metal casting.

- V6-24 Valve Cylinder Head.
- Impeller
- Steering Block for a car

DTM Sinterstation 2500



Volume di lavoro	380 X 330 x 460 mm
Laser	CO_2
Potenza	50 / 100 W
Spot	0.42 mm
Velocità di scansione	5000 mm/sec
Precisione di posizionamento	0.05 mm
Spessore layer	0.1 mm

METU SYSTEM

- EOS EOSINT P380 Rapid Prototyping System

General Properties
Plastic Laser Sintering System X,Y Axes Alternating Scanning
Technical Specifications
Work Envelope:
-X Axis: 340 mm
-Y Axis : 340 mm
-Z Axis : 600 mm
Layer Forming Thickness:
0.15mm +/-0.05 mm
Max Laser Power: 50 W
Z Axis Production Speed: 30 mm / saat
Max Scanning Speed: 5 m/s

Eosint P360

Selective Laser Sintering

Advantages:

- Cheap and no harmed healthy material,
- Large selection of used materials,
- Is not needed supported construction,
- Decreasing of destruction possibility of inside stresses.

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Selective Laser Sintering

Disadvantages:

- Roughness surface after final modification it means „stairs“ effect,
- Porosity of components,
- Different intensity in various parts of generated components,
- Material transformations are needing cleaning of the production device

EBM

ELECTRON BEAM MELTING

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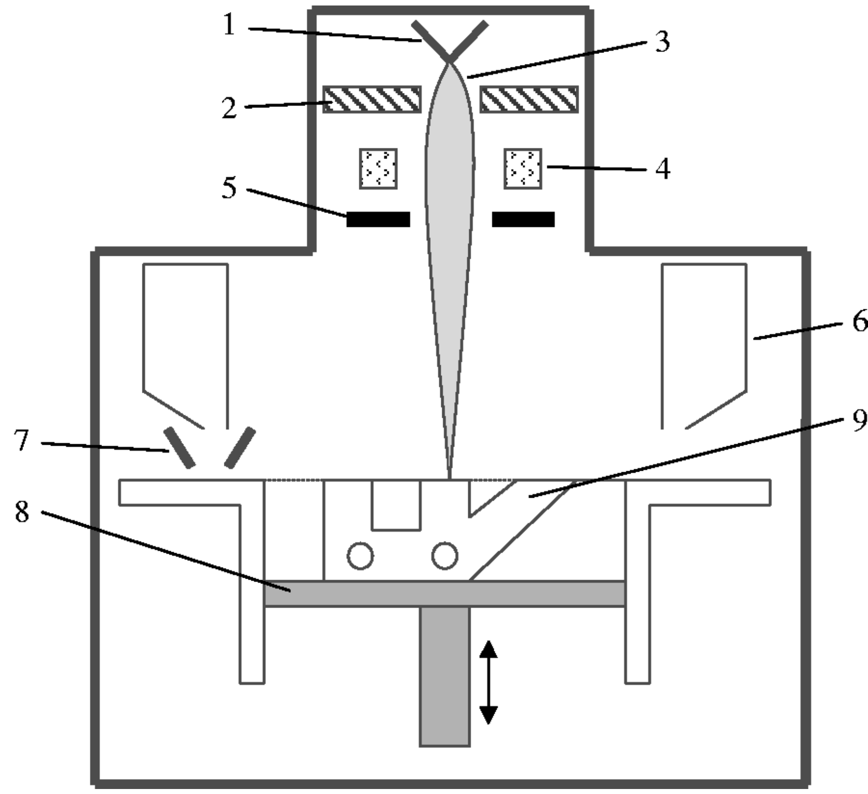
Electron Beam Melting (EBM)

- Electron Beam Melting (EBM) is a type of rapid prototyping for metal parts. The technology manufactures parts by melting metal powder layer per layer with an electron beam in a high vacuum. Unlike some metal sintering techniques, the parts are fully solid, void-free, and extremely strong.
- EBM is also referred to as Electron Beam Machining.
- High speed electrons .5-.8 times the speed of light are bombarded on the surface of the work material generating enough heat to melt the surface of the part and cause the material to locally vaporize.
- EBM does require a vacuum, meaning that the workpiece is limited in size to the vacuum used. The surface finish on the part is much better than that of other manufacturing processes.
- EBM can be used on metals, non-metals, ceramics, and composites.

Electron Beam Melting (EBM)

- Dispensed metal powder in layers
- Cross-section molten in a high vacuum with a focused electron beam
- Process repeated until part is completed
- Stainless steel, Titanium, Tungsten parts
- Ideal for medical implants and injection molds
- Still very expensive process



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Examples of EBM

ARCAM A2 machine for direct metal deposition

Components made of Ti and Co-Cr alloys

Biomedical components made of Ti alloys

LASER ENGINEERED NET SHAPING

Laser Engineered Net Shaping

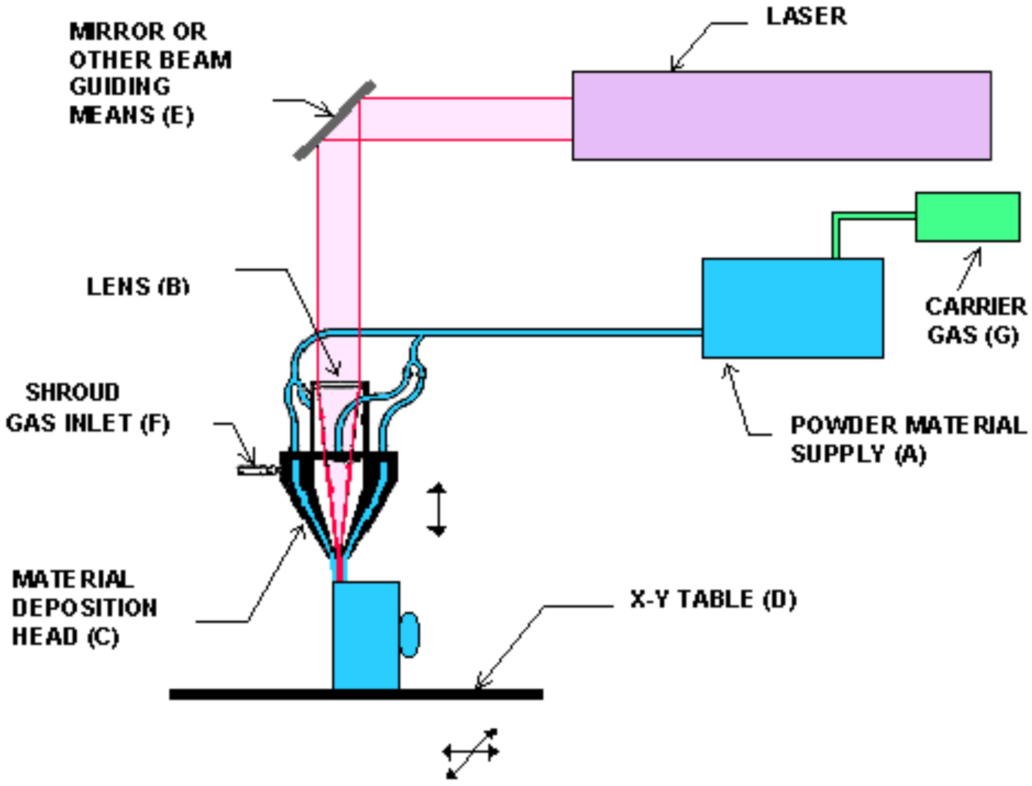

Fig. 8. Laser engineered net shaping.

Laser Engineered Net Shaping

- In development (Sandia Labs, Optomec)
- Fully Dense Metal parts with good metallurgical properties
- Laser melts metal powder
- Powder delivered coaxially with laser
- Inert gas protects weld pool
- Near net shape with some finish machining

http://home.att.net/~castleisland/sgc.htm

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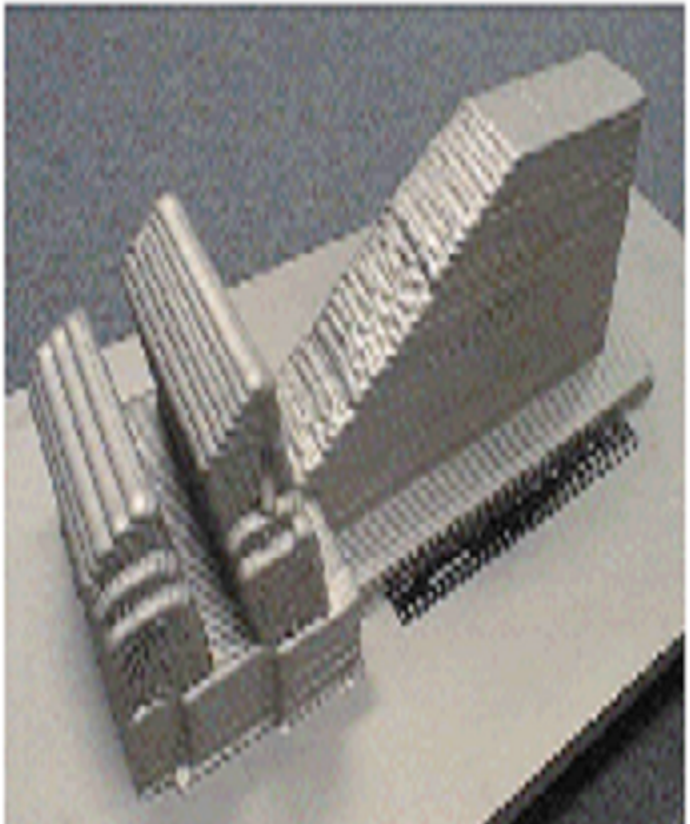
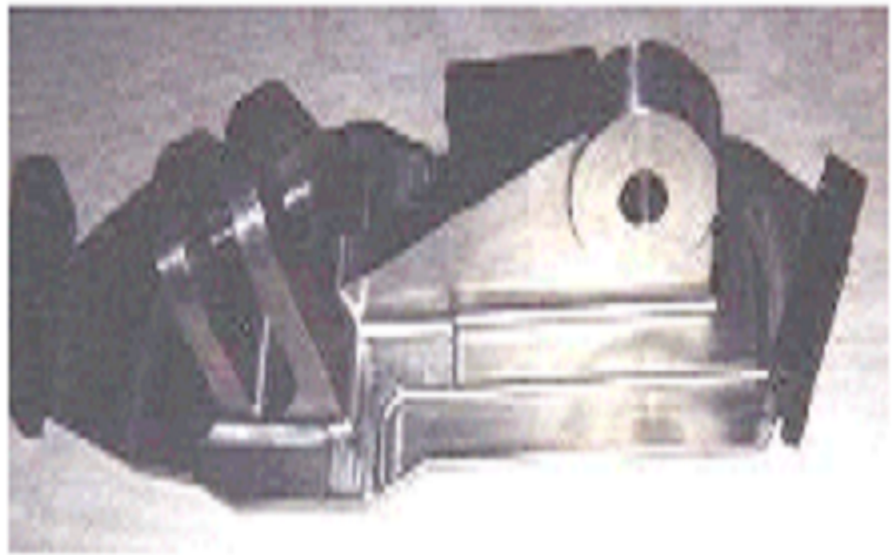
Laser Engineered Net Shaping

- In addition to titanium, a variety of materials can be used such as stainless steel, copper, aluminum etc.
- Materials composition can be changed dynamically and continuously, leading to objects with properties that might be mutually exclusive using classical fabrication methods.
- Has the ability to fabricate fully-dense metal parts with good metallurgical properties at reasonable speeds;
- Objects fabricated are near net shape, but generally will require finish machining.

Laser Engineered Net Shaping





Before and after finish machining

Laser Engineered Net Shaping

120x120x120 cm LENS Machine