The DMLS Technology

iTech Metal

“the manufacturing of the future”

www.e-manufacturing.it
Direct Metal Laser Sintering Technology (DMLS)

- Powder Metallurgy
- The DMLS Technology
- MET Company basic knowledge in Powder Metallurgy
- Materials
- Distinctive features of DMLS & advantages vs. traditional technologies
- Examples of Application
- DMLS Machines & Production capacity
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Powder Metallurgy

- Powder metallurgy is generally intended as a forming and fabrication technique consisting of different processing stages.

- The first stage, which is common for all techniques, is the **base material powdering**: the metal alloy is divided into many small individual particles. Different techniques are suitable to produce metal powder of different shapes and grain sizes.

- Next steps can vary depending on final consolidating technology. Well known technologies are **metal injection moulding** and **sintering**.

- Selective Laser Sintering is a well known process in the field of rapid prototyping used to build plastic prototypes.

- However, the increase in the power of Yd laser beams and the setup of new metal powder mix, similar to the mostly available metal alloys used in the industry, made possible the setup of a new process called DMLS (Direct Metal Laser Sintering) and the production of metal prototypes in a very short time with additive process.

- Because with DMLS the powder is melted and not sintered, better mechanical strength can be accomplished.

- In this way limited series and pre-production series are also available.

![Figure 1: SEM image of powdered metal](image-url)
The DMLS Technology

- The basic principle of the DirectMetal Laser Sintering (DMLS) Technology is to melt down thin layers (20 ÷ 60 μm) of Metal Powder with an electronically driven LASER beam (200W)

- Layer by layer, it is possible to build any kind of shape and geometry, even those which are impossible to obtain with any other kind of technology. The accuracy is ± 0,05mm.

- Resulting parts have same mechanical behaviour of those obtained through conventional techniques

- A deep basic knowledge on Powder Metallurgy dramatically improves the DMLS technology outputs.
Knowledge in DMLS

• Thanks to a deep knowledge of the DMLS technology and a long experience in new product development process, MET Company today is partner of big companies where the capabilities to reduce the Time-to-Market is a key factor in gain the competitive edge.

• MET Company have established a strict link with strategic technological partners in order to give to the Customer a personalised service and product.

• By following this strategy, we can offer to our Customers the following advantages:

  ✓ **Complete control of the entire process flow, starting from production of powder to delivery to the customer throughout process quality inspection.**

  ✓ **Full flexibility and availability to develop new product with the Customer**

  ✓ **Possibility to modify the product to perfectly “fit” the specific application**

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MET

e-manufacturing
**Materials**

- Using the DMLS Technology, parts made of the following materials can be obtained:

<table>
<thead>
<tr>
<th>Materials</th>
<th>Main mechanical properties</th>
<th>Main applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium alloy - AlSi10Mg</td>
<td>UTS over 340 MPa</td>
<td>Lightweight mechanical components. Prototypes. Pre-series mould for plastic components.</td>
</tr>
<tr>
<td>Stainless steel 15-5</td>
<td>Hardenable stainless steel (over 40 HRC)</td>
<td>High-temperature corrosion-resistance mechanical components.</td>
</tr>
<tr>
<td>Stainless steel 17-4 PH1</td>
<td>Not hardenable stainless steel</td>
<td>High-temperature corrosion-resistence mechanical components.</td>
</tr>
<tr>
<td>Maraging steel</td>
<td>Hardness over 54HRC</td>
<td>Production mould inserts with conformal cooling.</td>
</tr>
<tr>
<td>CobaltChrome superalloy</td>
<td>High resistance stainless material. UTS over 1200 MPa. Hardness over 54HRC</td>
<td>High-temperature corrosion-resistence mechanical components. Aerospace, biomedical.</td>
</tr>
</tbody>
</table>

### Table 1:
Materials and applications

- Any other composition can be evaluated upon request
Distinctive features of DMLS

• As introduced before, DMLS is an innovative additive metals technology. Because of its extremely high flexibility, it is used in many fields of application such as orthopaedics & dental industries, rapid prototyping and tooling.

• In addition, because of some of its distinctive features, the DMLS technology finds unexpected applications in aerospace and automotive industry.

<table>
<thead>
<tr>
<th>Sectors</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorsport</td>
<td>Mechanical components, pistons, valves</td>
</tr>
<tr>
<td>Aerospace</td>
<td>High-strength lightweight components</td>
</tr>
<tr>
<td>Engineering &amp; Energy</td>
<td>Power unit blades, components for test benches</td>
</tr>
<tr>
<td>Nautics</td>
<td>Special flanges, caps, pump bodies</td>
</tr>
<tr>
<td>Industrial design</td>
<td>Design components</td>
</tr>
<tr>
<td>Bikes</td>
<td>High-strength lightweight components</td>
</tr>
<tr>
<td>Professional “tools”</td>
<td>Metal parts of pliers, special tools</td>
</tr>
<tr>
<td>Textile industry</td>
<td>Complex components for textile machinery</td>
</tr>
</tbody>
</table>

Table 2: Market sectors and applications

• The technology uses a laser to melt a developing range of fine metal powders to form a pre-defined shape. Each part is built up layer by layer and is directly driven from CAD data through a software interface. From electronic data (STEP or IGES files) directly to the finished product in very short times, without any further internal phase and without any waste in material consumption: from this the name “e-manufacturing”.

• Key features of the technology are increased geometric freedom, reduced waste product, lights out operation and the ability to safely produce components in reactive materials such as Titanium and Aluminium.

• In the following pages, the distinctive features of the DMLS will be detailed.
Distinctive features of DMLS vs. traditional technologies

Figure 4:
Comparison of mechanical performances amongst DMLS and traditional technologies
CobaltChrome MP1

Relative density: approx. 100 %
density: 8.29 g/cm³
Operating temp.: Max. 1150 °C
Melting point: 1350-1430 °C

Thermal conductivity:
- 20 °C: 13 W/mK
- 300 °C: 18 W/mK
- 500 °C: 22 W/mK
- 1000 °C: 33 W/mK

Thermal expansion:
- 20 – 500 °C: 13.6 x10⁻⁶ m/mK
- 500 – 1000 °C: 15.1 x10⁻⁶ m/mK

Figure 5:
Micrography of DMLS metal structure
CobaltChrome MP1

DMLS components overpasses the standard fatigue test:

- Cycles: 10 millions
- Load: 440MPa
- Frequency: 45Hz

Figure 6: DMLS samples after fatigue test

Figure 7: Report of STORK Laboratories
AlSi10Mg

Cost comparison

Figure 8:
Cost per unit vs quantity.
Comparison amongst DMLS and Die Casting
Distinctive features of DMLS

Rapid manufacturing of complex geometries

Figure 9: 3D .IGS model of kite-surf hook

Figure 10: Two kite-surf hooks: stainless steel and bronze

Liquid-cooled operating structures

Figure 11: Prototype of liquid cooled blade
Distinctive features of DMLS

Complex geometrical structures (internal cavities development)

Figure 12:
Propeller collector. Material: titanium

Rapid prototyping of complex geometries

Figure 13:
Rotor fan for aerospace. Material: titanium
Distinctive features of DMLS

Long and cave component with complex shape

Figure 14: 3D .IGS model of Gun loader.

Figure 15: Gun loader.
Material: stainless steel

Lightweight Structures

Figure 16: Honeycomb structure.
Material: titanium
Distinctive features of DMLS

Complex geometrical structures and thin walls

Figure 17:
Gas exhaust protection grid for DUCATI race team.
Material: titanium

Undercuts

Figure 18:
Clip for automatic packaging machine.
Material: stainless steel.
Distinctive features of DMLS

Bio-compatible surface finishing
(dental prosthesis, orthopaedic prosthesis)
Examples of Application

• Heavily Complex Geometries / Internal cavities

• Conforming Cooling Inserts:
Examples of Application

• Lightweight Structures/Thin walls

• Rapid Prototyping:
Examples of Application

• Dental Prosthetics:

• Orthopaedics:
Distinctive features of iTechMetal service

Added value

• DMLS technology is the most competitive for metal components with complex shape in small series production (up to 100 pieces per year).

User needs satisfied

• Very short delivery times (within 6-8 days)
• Very good mechanical properties (over UTS 1300 MPa)
• Certificated materials and quality controls
• Not simple prototypes but true pre-production series.
• Any complex shape is possible

In brief, we reduced and eliminated …

Any distance: you can send us your file and we can deliver your parts in every place in the world.

Delivery times: the process is “addictive”, no waste in raw materials, one single step process, from electronic data.

Shape constraints: we can realize any shape, free of any constraints; designers or any industrial needs are possible.
The DMLS Machines & MET Company production capacity

- Nitrogen or Argon gas process
- Process room temperature: 40 °C
- 200W Yd lase power
- Max Size of the process room: 250x250x215mm
- Production rate: 2-20mmc/sec
- Layers thickness: 20-60µm
- Electronic data format: IGES/STP
- Accuracy: +/- 0.05mm

<table>
<thead>
<tr>
<th>Model</th>
<th>Qty</th>
<th>Technology</th>
<th>Manufacturer</th>
<th>Dimension</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>M270</td>
<td>1</td>
<td>DMLS</td>
<td>EOS GmbH</td>
<td>250 x 250 x 215</td>
<td>Titanium, Aluminium</td>
</tr>
<tr>
<td>M270</td>
<td>1</td>
<td>DMLS</td>
<td>EOS GmbH</td>
<td>250 x 250 x 215</td>
<td>Stainless Steel, ChromeCobalt</td>
</tr>
<tr>
<td>M270</td>
<td>1</td>
<td>DMLS</td>
<td>EOS GmbH</td>
<td>250 x 250 x 215</td>
<td>Inconel (?)</td>
</tr>
<tr>
<td>P380</td>
<td>1</td>
<td>SLS</td>
<td>EOS GmbH</td>
<td>350 x 350 x 320</td>
<td>Polyamid PA6.6</td>
</tr>
<tr>
<td>P380</td>
<td>1</td>
<td>SLS</td>
<td>EOS GmbH</td>
<td>350 x 350 x 320</td>
<td>PA6.6 + Glass fiber</td>
</tr>
<tr>
<td>P380</td>
<td>1</td>
<td>SLS</td>
<td>EOS GmbH</td>
<td>350 x 350 x 320</td>
<td>PA6.6 + Aluminium filler</td>
</tr>
<tr>
<td>P380</td>
<td>1</td>
<td>SLS</td>
<td>EOS GmbH</td>
<td>350 x 350 x 320</td>
<td>PA6.6 + Carbon fiber</td>
</tr>
</tbody>
</table>
Contacts

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