The Global Leader in Laser-Sintering Systems
## EOS of North America, Inc.

### Agenda

1. **Who is EOS and our focus?**
2. **EOSINT Direct Metal Laser-Sintering (DMLS)**
3. **EOSINT Plastic Laser-Sintering**
4. **EOSINT High-Temperature Plastic Laser-Sintering**
Company Overview

- EOS GmbH was founded in 1989
- Over $125M (US) in revenue with 350+ employees globally
- Over 1100 systems installed in 30 countries
- EOS has sales/service/application offices in 10 countries (Germany, UK, France, Italy, USA, India, Singapore, Korea, Taiwan, Finland)
- Distributors in 22 countries
Design-driven manufacturing with EOS Laser-Sintering Technologies

<table>
<thead>
<tr>
<th>Freedom of Design</th>
<th>Cost advantage</th>
<th>Productivity advantage</th>
<th>Customization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lightweight</td>
<td>Small production series</td>
<td>Time-to-market flexibility</td>
<td>Individualized parts</td>
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<td>Integrated functionality</td>
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The EOS Vision

EOS Vision

EOS will be the leading partner for developing and providing integrated e-Manufacturing solutions.
What does it mean?

**Strategic cornerstones**

- **Stay innovation & quality leader** for AM technology
- **Drive maturity of AM technology** (quality, robustness, production readiness, e.g. validated AM process)
- **Offer** complete, integrated (industry specific) solutions
- **Develop partner network** to better address customer needs
- **Define new types of offerings and business models**
- **Consult OEM / OEM supplier** to develop manufacturing scenarios
- **Create more market awareness** - focus benefits and value add of Additive Manufacturing
The EOSINT Product Line

FORMIGA P 100

EOSINT P 395

EOSINT P 760

EOSINT P 800

EOSINT M 280

Pictures not to scale
EOSINT M 280

Features & benefits

- 400W laser option
- XY Build area – 250mm x 250mm
- Z axis stroke 325mm (12.8in)
- Dual gas – N₂ and Ar
- Improved process gas management ("laminar flow")
- Optional glove-box door
# EOSINT M Materials - Overview

<table>
<thead>
<tr>
<th>Material name</th>
<th>Material type</th>
<th>Typical applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>EOS MaragingSteel MS1</td>
<td>18 Mar 300 / 1.2709</td>
<td>Injection moulding series tooling; engineering parts</td>
</tr>
<tr>
<td>EOS StainlessSteel GP1</td>
<td>Stainless steel 17-4 / 1.4542</td>
<td>Functional prototypes and series parts; engineering and medical</td>
</tr>
<tr>
<td>EOS StainlessSteel PH1</td>
<td>Hardenable stainless 15-5 / 1.4540</td>
<td>Functional prototypes and series parts; engineering and medical</td>
</tr>
<tr>
<td>EOS NickelAlloy IN718</td>
<td>Inconel™ 718, UNS N07718, AMS 5662, W.Nr 2.4668 etc.</td>
<td>Functional prototypes and series parts; high temperature turbine parts etc.</td>
</tr>
<tr>
<td>EOS NickelAlloy IN625</td>
<td>Inconel™ 625, UNS N06625, AMS 5666F, W.Nr 2.4856 etc.</td>
<td>Functional prototypes and series parts; high temperature turbine parts etc.</td>
</tr>
<tr>
<td>EOS CobaltChrome MP1</td>
<td>CoCrMo superalloy, UNS R31538, ASTM F75 etc.</td>
<td>Functional prototypes and series parts; engineering, medical, dental</td>
</tr>
<tr>
<td>EOS CobaltChrome SP2</td>
<td>CoCrMo superalloy</td>
<td>Dental restorations (series production)</td>
</tr>
<tr>
<td>EOS Titanium Ti64</td>
<td>Ti6Al4V light alloy</td>
<td>Functional prototypes and series parts; aerospace, motor sport etc.</td>
</tr>
<tr>
<td>EOS Aluminium AlSi10Mg</td>
<td>AlSi10Mg light alloy</td>
<td>Functional prototypes and series parts; engineering, automotive etc.</td>
</tr>
</tbody>
</table>

Qualified and commercially released materials are listed here. Further materials are under development, please ask for details.
EOSINT M - applications

e-Manufacturing applications are gaining maturity especially in medical and aerospace.

**Examples of market and application status**

- **Dental restorations**: more than 40 M270 systems sold for series production. CoCr SP2 is recertified according to the new Medical Device Directive 93/42/EEC.

- **Tooling**: more than 45 M270 systems sold for series production of moulds for injection molding and die casting.

- **Aerospace market**: more than 50 M270 systems sold to end users like Airbus, GE, P&W, Boeing, Avio, Snecma. IN718, IN625 certified. Several service providers are supplying parts to end users. DMLS being qualified for test beds and flying parts.

- **Qualification/Certification**: End users are currently qualifying DMLS for production.
DMLS in the Medical Market

**Orthopedic Implants**

- **Trilliant Surgical** got first 510k approval (FDA) in the US.
  - Manufacturing partner is **MTI**
- **MTI** is working on another 510k approval with **Kapstone Medical** for a spinal implant.
- **Pipeline Orthopedics (US)** will market Titanium implants early - 2012
- **Stanmore Implants** wants to market CoCr and Titanium implants in mid-2012
- **Smith & Nephew** validating Titanium on M270 Xtended for patient specific implants (Knee, hip and latest interest of the Spine division)
CobaltChrome MP1 superalloy for fully-functional aircraft engine parts

Prototypes for Test Rigs

• **Requirement:**
  • functional prototypes for developing helicopter gas-turbine engine components
  • capable of running in test-bed conditions, e.g., high strength at high temperature

• **Solution:**
  • EOSINT M 270 with EOS CobaltChrome MP1 superalloy

• **Result:**
  • can be built fully dense in 82 hours
  • can be automatically polished
  • properties fulfill requirements for running on test-bed

Straightener for an helicopter gas-turbine engine. PEP / Turbomeca / Best in Class
Fuel Injection - Swirlers

DMLS Swirler demonstrates:

- Highly complex design built as ‘one piece’
- Dramatic reduction in time to create
  - 2 weeks vs. 6 weeks
  - Significant cost reduction (~50% less)
  - Increased robustness
- No braze joints, etc.
DMLS Tooling Example

DMLS reduces cycle time up to 42%

• Challenge
  • Cycle time: confirm results figured out with simulation
  • Reduce time to market
  • Demonstrate cost saving on year basis calculation

• Solution
  • Hybrid tool, one cavity
  • DMLS tool insert with conformal cooling channels

• Advantages
  • Reduction of scrape rate
  • Reduction of product warpage
  • Cycle time reduction: 42%
  • Cost saving (on a yearly base, 240,000 Products/year): approximately 24,000 Euro (*)

Source: EOS, Polymold, BKL

EOS 2012
The EOSINT P product line – solutions for all kinds of demands

**New benchmarks for productivity and flexibility**

**FORMIGA P 100**  
(200 x 250 x 330mm)

**EOSINT P 395**  
(340 x 340 x 620mm)

**EOSINT P 760**  
(700 X 380 x 580mm)

**EOSINT P 800**  
(700 X 380 x 580mm)

Pictures not to scale
EOS offers a variety of polymer materials for plastic laser-sintering systems

**Polymer materials and its typical applications:**

<table>
<thead>
<tr>
<th>Name of material</th>
<th>Material type</th>
<th>Typical applications</th>
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<tbody>
<tr>
<td>ALUMIDE®</td>
<td>Aluminium-filled PA 12</td>
<td>Dimensional accurate, high machinable illustrative models, tooling inserts, jig manufacture</td>
</tr>
<tr>
<td>CarbonMide®</td>
<td>Carbon fibre filled PA 12</td>
<td>Light weight, mechanically stressed, functional parts</td>
</tr>
<tr>
<td>PA 2200/2201</td>
<td>Polyamide 12</td>
<td>Illustrative models, functional parts/end products, spare parts</td>
</tr>
<tr>
<td>PA 2202 black</td>
<td>Pigment-filled PA 12</td>
<td>Functional parts, mechanical highly stressed parts in design quality, spare parts</td>
</tr>
<tr>
<td>PA 2210 FR</td>
<td>Flame-retardant polyamide 12</td>
<td>Functional parts with requirements on fire protection**</td>
</tr>
<tr>
<td>PA 3200 GF</td>
<td>Glass-filled polyamide 12</td>
<td>Housing components, mechanically and short-term thermally heavily used parts, wear resistant parts</td>
</tr>
<tr>
<td>PEEK HP3</td>
<td>Polyaryletherketone</td>
<td>Parts with requirements on high temperature, flame retardation, wear and chemical resistance</td>
</tr>
<tr>
<td>PrimeCast® 101</td>
<td>Polystyrene</td>
<td>Lost patterns, master patterns for plaster/vacuum casting</td>
</tr>
<tr>
<td>PrimePart®</td>
<td>Polyamide 12</td>
<td>Functional, mechanically stressed parts/end products, illustrative models, spare parts*</td>
</tr>
<tr>
<td>PrimePart® DC</td>
<td>Polyamide 11</td>
<td>End products, mechanically stressed parts, impact resistant components</td>
</tr>
</tbody>
</table>

* same as PA 2200/2201, but reduced refreshment rate
** up to UL 94/V0
EOSINT P 760 for the economic production of series

Example of a series production

- Direct production of large quantities of small parts
- More than 4,000 parts per job in one single process
- 100 Watt laser power with up to 12 meters/second - possible with two lasers and two scanners
- Quick change of job due to exchangeable frame system
Example for Production Applications
Multi-Functional Designs

Previous (Kevlar/Rotomold) Configuration

- Attach Straps Eliminated
- Part Count Reduction
- Quick & Easy Installation

New (SLS) Configuration

- Multiple Ducts Combined to Single-Piece Duct

Conformal Shapes Achieved and Internal Flow Features Added
Current Production Examples

- **Disposable instruments** successful at:
  - Materialise (Biomet, Zimmer and others soon)
  - Smith & Nephew (US)
  - Medacta (IT)
  - Amplitude (FRA)

- **Requirements**:
  - Reliable and verified P process
  - Traceability for the powder
Gadgets

Prototyping, Design Elements and Functional Parts
System and configuration

- Only commercially available machine in the world for high-temp materials (above ~250°C)
- Build area: 700 x 380 x 560 (mm)
- Building speed: up to 10mm/h
- Layer thickness: 120µm
- Processing Temperature – Up to 370°C
- EOS PEEK HP3, more materials in development
- Process shrinkage in X/Y ~5%
Laser-sintering of high-performance polymers allows new applications to utilize e-Manufacturing

**EOS PEEK HP3 – especially designed for the EOSINT P 800**

- **Outstanding material data:**
  - tensile strength up to 95 MPa
  - tensile modulus up to 4400 MPa
  - long term usability between 180 °C and 260 °C

- **Exceptional performance:**
  - high chemical resistance
  - flame retardant conform UL 94- V0
  - biocompatibility
  - sterilisability

- **Suitable for applications e.g. in medicine, aerospace industry or motorsports → Rapid manufacturing**
Questions?