Manufacturing industries face a host of challenges from bringing products to market faster and digitization to producing ever more complex components. 3D printing technologies support companies by shortening the time from design to production, developing new ways to manufacture and transforming supply chain from just-in-time to here-and-now.
MARKET DRIVERS

3D PRINTING BENEFITS & CHALLENGES

SOLUTIONS
DRIVING INNOVATION TOWARDS THE FUTURE

- Labor and Time Intensive
  - PRE-INDUSTRIAL

- Standard Mass Production Methods
  - INDUSTRIAL

- Internet & Automation
  - DIGITALIZATION

- Democratization & Decentralized Manufacturing
  - INDUSTRY 4.0

3D Printing - Prototyping, Complex designs
VARIETY OF END APPLICATIONS

- Light weight, reduced conception time and inventory
- Light weight, complex parts & reduced assembly process
- Decentralized manufacturing & reduced inventory
- Customization & freedom of design
- Customization & Biocompatibility
MARKET DRIVERS

3D PRINTING BENEFITS & CHALLENGES

SOLUTIONS
DIGITAL VS. ANALOG

Can we do this with traditional processing methods?
### Different Technologies Different Benefits

<table>
<thead>
<tr>
<th>Technology</th>
<th>Parts built through polymerization</th>
<th>Parts built through bonding agent</th>
<th>Parts built through melting</th>
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</thead>
<tbody>
<tr>
<td>Plastic</td>
<td>SL</td>
<td>BJ</td>
<td>FDM (LS, MJF)</td>
</tr>
<tr>
<td>Metal</td>
<td>BJ</td>
<td>LM</td>
<td>EBM</td>
</tr>
<tr>
<td>Ceramic</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

- **SL**: Sintered Layer
- **PJ**: Powder Jet
- **BJ**: Binder Jet
- **FDM**: Fused Deposition Modeling
- **LS**: Laser Sintering
- **MJF**: Multi Jet Fusion
- **LM**: Laser Melting
- **EBM**: Electron Beam Melting

*Potential Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Plastic</th>
<th>Metal</th>
<th>Ceramic</th>
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<tr>
<td>Accuracy</td>
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<td>Mechanical Properties</td>
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<td>Material Availability</td>
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<td><img src="#" alt="Red" /></td>
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Estimated characteristics comparison
CHALLENGES OF 3D PRINTING

COST PER PART

SPEED, RELIABILITY AND THROUGHPUT

PART TO PART REPEATABILITY

OVERCOME TRADITIONAL METHODS

MATERIAL AVAILABILITY
# MARKETS & APPLICATIONS FOR POLYMER 3D PRINTING

<table>
<thead>
<tr>
<th>INDUSTRY</th>
<th>CURRENT APPLICATIONS</th>
<th>FUTURE TARGET APPLICATIONS</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Non critical cabin and structural components, assembly tooling</td>
<td>Structural components, high volume cabin components</td>
</tr>
<tr>
<td></td>
<td>Prototypes, assembly tooling, functional test parts for concept cars</td>
<td>Interior components, customized parts for product differentiation</td>
</tr>
<tr>
<td></td>
<td>Models, prototypes, custom low complexity products</td>
<td>On-demand consumer products and end use components</td>
</tr>
<tr>
<td></td>
<td>Anatomical models, surgical tools and guides, implants, upper extremity prosthetics</td>
<td>High realism and multi material models, load bearing implants, lower extremity prosthetics</td>
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</table>
UNRIVALED SMOOTH TOUCH FINISH (LASER SINTERING)

Orgasol® Invent Smooth

- Polyamide 12
- Laser sintering
- Excellent part detailing
- Maximum reuse of powder not used during printing
- Smooth finish resembling that of injection molded parts (unobtainable with other materials using laser sintering)
- Post-treatment not necessary
- Excellent color sustainability
RIGIDITY AND FLEXIBILITY WITH A BIOBASED MATERIAL

**Rilsan® Invent Natural and Black**

- Polyamide 11, biobased 100% renewable
- Excellent processing characteristics (laser sintering)
- Superior mechanical properties
- Impact resistant
- Great elasticity and ductility
- Meets USP Class VI requirements (natural)
- Matte finish (black)
- For optical applications: flexibility and rigidity of eyewear that other classic 3D printing plastics can’t obtain
Rilsan® PA11: MATERIAL OF CHOICE FOR RAPID MANUFACTURING

Stress/strain curve at 23°C (ISO 527 1A)

- Polyamide 12
- Polyamide 11

Better mechanical properties
Unequaled elasticity thanks to specific crystalline structure

Laser sintered parts
Rilsan® PA11: MATERIAL OF CHOICE FOR RAPID MANUFACTURING

Fatigue curve at 23°C & 5 Hz direction Z (ISO 527 1B notched 0.7 mm)

- **Polyamide 12**
- **Polyamide 11**

From here, no more breakage

PA11 +60% better in fatigue

Laser sintered parts
Rilsan® PA11: MATERIAL OF CHOICE FOR RAPID MANUFACTURING

Relaxation from 20% strain at 23°C direction XY (ISO 527 1A)

Laser sintered parts

Polyamide 11
Polyamide 12

After 18h @ 80°C
PA11 much better than PA12

After 3h @ 23°C
PA11 better than PA12

After stress relaxation,
~ same behavior
Rilsan® PA11: MATERIAL OF CHOICE FOR RAPID MANUFACTURING

Influence of temperature in impact resistance (Charpy unnotched impact test ISO 179 1eU)

<table>
<thead>
<tr>
<th>Temperature</th>
<th>XY axis</th>
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<td>23°C</td>
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<td>100</td>
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<td>100</td>
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</tbody>
</table>

No break value

Impact strength (kJ/m²)
3D PRINTING PROPERTIES WITH POLYAMIDE 11

- Strength & Toughness
- Ease of Processability
- Elastic Memory
- Impact Resistance
- Surface Aspect
3D PRINTING MARKET PRESENTATION

Technical Polymers
Summary of Arkema’s Policy Regarding Medical Device Applications of Arkema Products

Arkema seeks business relationships with customers who participate in the health care industry. Arkema is committed to maintaining safety in supplying the health care industry, and works with the regulatory agencies and its customers to deliver high quality products.

Arkema’s core principles that guide its behavior with respect to the use of its products in medical device applications are provided below.

Non-Temporary Implants
Arkema does not supply any products to be used in medical device applications that constitute a non-temporary implant (i.e., that, in whole or in part, may be in contact with a patient’s skin, body fluids or tissues for more than 30 days).

Temporary Implants
Arkema may supply products to be used in medical device applications involving temporary implants (30 days or less) in contact with a patient’s skin, body fluids or tissues. Arkema only supplies customers with products for temporary implants in accordance with its medical contractual provisions, and where other specific corporate risk management conditions are met.

Other Medical Device Applications (Non Implant)
Arkema may supply products for use in all other medical device applications. Arkema will use its good business judgment to set specific Arkema corporate risk management conditions in such circumstances.

Design, Manufacture and Sale of Medical Devices
Arkema does not design, manufacture and/or directly sell any medical devices. Arkema also does not co-design, or offer assistance to any purchaser of Arkema products, in their design, manufacture and/or sale of products for medical devices.

Medical Grade Products
Arkema has designated specific medical grade compositions for its products. Customers who intend to use Arkema products in a medical device application will only be supplied with these specific medical grade compositions. No other Arkema products may be supplied for use in medical device applications.

Appropriate Use of Arkema Products
Arkema will not itself perform clinical medical studies concerning the use of its products for any particular medical device application. Arkema will not engage in any type of suitability determinations for the use of its products in any medical device applications.

Responsibility of Medical Device Manufacturer
It is the sole responsibility of the manufacturer of the medical device to determine the suitability (including biocompatibility) of all raw materials, products and components, including any medical grade Arkema products, in order to ensure that the final end-use product is safe for its end use; performs or functions as intended; and complies with all applicable legal and regulatory requirements. It is the sole responsibility of the manufacturer of the medical device to conduct all necessary tests and inspections and to evaluate the medical device under actual end-use requirements and to adequately advise and warn purchasers, users, and/or learned intermediaries (such as physicians) of pertinent risks and fulfill any postmarket surveillance obligations. Any decision regarding the appropriateness of a particular Arkema material in a particular medical device should be based on the judgment of the manufacturer, seller, the competent authority, and the treating physician.

Trade Names
Unless Arkema expressly agrees by written contract, Arkema product names, trademarks and the Arkema name shall not be used with any medical devices, and customers should not represent to others that Arkema permits, recommends, or endorses the use of our products in any medical devices.

Warranties
ARKEMA WILL NOT WARRANT THAT ITS PRODUCTS ARE SUITABLE FOR USE IN ANY MEDICAL DEVICE OR MEDICAL APPLICATION.

ark.ma/MEDpolicy