



Freeform Injection Molding

A platform for Seamless growth

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Director Business Development



Exec. Summary

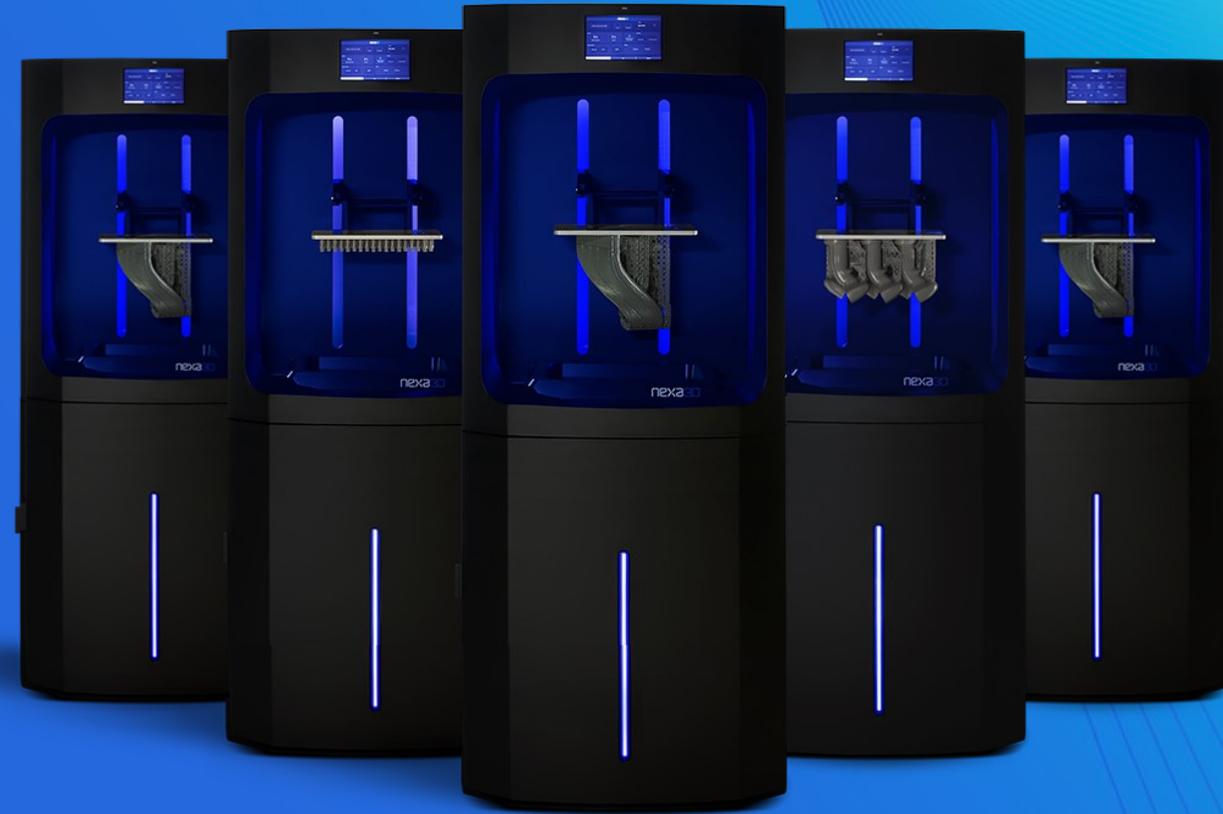
Freeform Injection Molding is 3D-printing for injection molders...

- ... Which is fully compatible with existing machines and materials
- ... Which simplifies the development of complex parts in complex materials
- ... Which enables dramatic cost and lead-time reductions while providing new levels of design freedom
- ... Which may be implemented as a packaged solution having a cost of less than USD 30.000 – or as-a-service



Agenda

- Why FIM for Injection Molders?
- What is FIM?
- What are the key elements of FIM?
- What are key references?
- What about sustainability?



Why implement FIM as an Injection Molder?

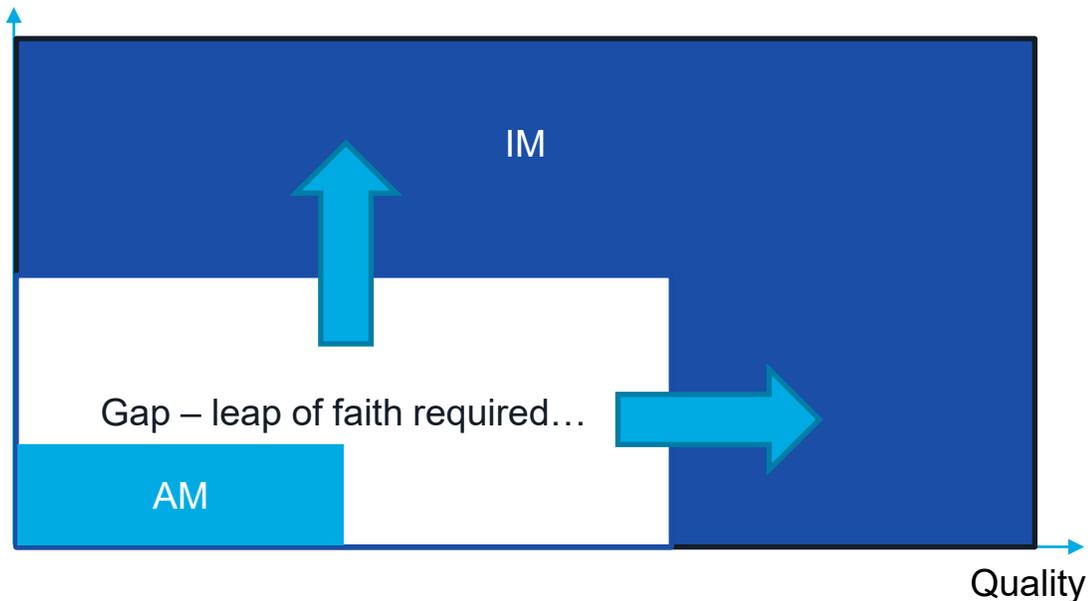
Freeform Injection Molding is the first-ever platform that seamlessly integrates 3D-printing into the injection molder's workflow. Based on ultrafast 3D-printers and proprietary resins from Nexa3D, FIM allows injection molders to prototype and test complex injection-molded parts with the short lead-times and design freedoms known from 3D-printing – and at a fraction of the costs normally associated with pilot tooling.

This translates to increased competitiveness, more projects and more revenue...

... And a best-in-class 3D-printer is thrown in for free...

The Impact in Short

Quantity



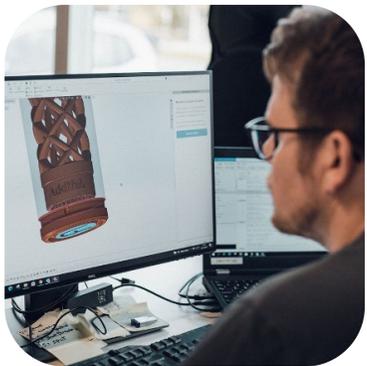
AM has enabled rapid prototyping, and is emerging as viable alternative for some (low-volume) production applications.

However, IM still leads on quality and quantity, and manufacturers still have to invest in tooling to get injection-molded parts. This requires leap-of-faith investments and time-consuming decision-making

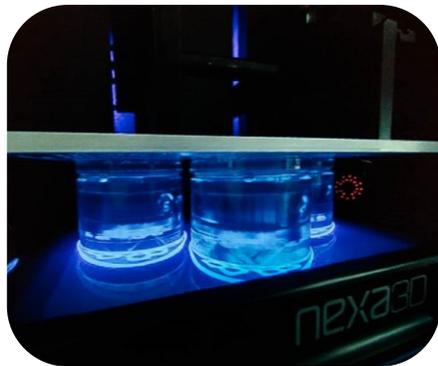
FIM allows manufacturers to 3D-print both parts, injection mold tools and tool inserts, enabling a seamless transition from 3D-printed prototypes to injection-molded products, without compromising on design freedom and selection of materials

What is Freeform Injection Molding (FIM)?

- Video [here](#)



1. Design of mold



2. Print-Clean-Cure



3. Inject mold



4. Demold

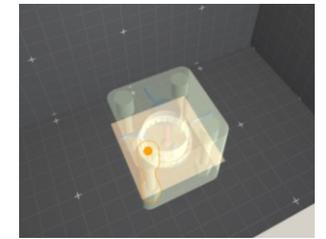
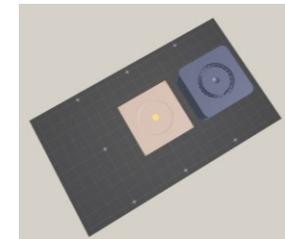
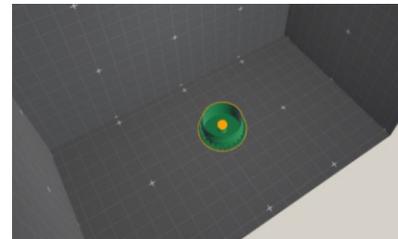
Freeform Injection Molding is 3D-printed tooling for complex parts – and the simple ones

Step 1: Design the mold

One of the things setting FIM apart is the extreme ease it brings to mold design. Since no ejector pins, sliders, cores – or even split lines – are needed, a complex mold can be designed in a matter of hours instead of weeks. And part design changes can be made and tested immediately and sometimes simultaneously, enabling a transformative development speed increase. “Focus on the part, not the tool” is a key message.

See a couple of mold design examples here (done with conventional CAD), and reach out to Lasse Staal for an online demo of the Nexa3D Mold Generator software, that partially automates the design of simple molds

- Mold for [rectangular plate](#)
- Mold for [latticed sphere](#)
- Mold for [gear wheel](#)
- Mold for [buckle](#)



Step 2: Print-Clean-Cure the Mold

The printing, cleaning and curing of high-quality molds and mold inserts follows the same principles as those applying to conventional 3D-printed parts and are done using the Nexa3D LSPc printers (XiP, XiP Pro, NXE), and the washing and curing stations already on the market.

For cleaning, the Nexa3D xWASH solvent, alternatively IPA, are recommended.

Elements involved in the printing/cleaning/curing of molds and parts



Print



Clean & Cure



xMOLD Resin



xCLEAN solvent (or IPA)

Step 3: Injection Molding

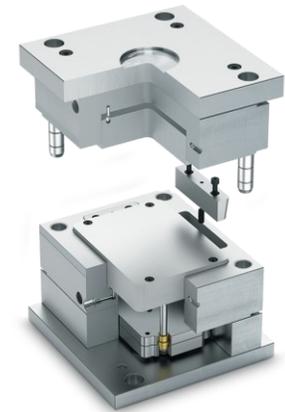
For the injection molding, any conventional injection molding press may be used. We provide guidance on the selection of injection molding presses and other accessories, with the machines from Dr. Boy as a clear preference.

Please note that while most injection moldable materials are compatible with the solvents used in Freeform Injection Molding, the following materials are not recommended for designs requiring soluble tool elements: Polycarbonate (PC), Polyethylene terephthalate (PET), Polybutylene terephthalate (PBT), ester-based TPU and Polyamide-imide (PAI). These materials may degrade under the influence of the alkaline solvents used in Freeform Injection Molding

Elements involved in the injection molding



Injection molding press
(desktop or industrial)



For industrial – mold base unit

More on Mold Frames and Hybrid Tooling

Mold frames

- FIM molding involves the use of mold bases that comprise ejector pin panels + detachable mold frames w. pockets that [receive and hold](#) the printed molds during injection. After injection, the entire printed mold is [ejected](#) from the pocket. This approach is different from that used by other suppliers of printed tooling, who screw mold halves onto the injection molding press for repeated injection mold cycles.
- We offer a standard [quick-change solution](#) from Meusburger (four different sizes spanning machines from 6 to 150T clamp force), as well as a mold frame service enabling our customers to order custom frames if they cannot get these made locally

Hybrid Tooling (for advanced users)

- FIM handshakes seamlessly with conventional injection mold tooling to offer increased design freedom. 3D-printed soluble inserts allow injection molders to skip sliders, cores and other mold complications for low-volume manufacturing applications, and in addition allow the inclusion of “impossible-to-mold” design features.
- The key benefits with this approach are that that 3D-printed soluble inserts are considerably cheaper to print than entire 3D-printed cavities, and that they are compatible with both conventional molding tools and 3D-printed tooling.

Step 4: Demolding the part

In a conventional injection molding process, demolding consists of pulling the mold elements apart and ejecting the part. Where molded materials and part geometries permit, this is also possible for FIM molds. However, the unique and patented solubility of FIM molds comes in handy where one or more mold elements cannot be easily removed from the molded part.

In essence, injection molders do not have to be concerned with getting a part out of a mold in the development phase. This simplifies prototype mold designs and allows designer to focus on the product

Furthermore, FIM users benefit from the option of enhancing the functionality of conventional molds by incorporating soluble inserts to easily manage complex geometries (see also next slide)

Elements involved in the demolding



Demolding Station – ventilation recommended



Sodium Hydroxide

How do I access FIM?

	Mold design	Mold printing	Injection Molding	Demolding	Comments
1. As-a-Service	Outsource	Outsource	Outsource	Outsource	For non-LSPc owners, and LSPc owners seeing very low demand for IM parts
2. Asset-light	Outsource	Insource, w. LSPc and xMOLD resin	Outsource	Outsource	For LSPc owners wanting to use their printers for both direct AM and FIM, w.o. investing
3. As-a-system	Insource, w. Mold Generator	Insource, w. LSPc and xMOLD resin	Outsource	Insource, w. demolding station	For LSPc owners wanting faster through-put, reduced dependency, lower costs
4. All-inclusive	Insource, w. Mold Generator	Insource, w. LSPc and xMOLD resin	Insource w. installed-base or new IM capacity	Insource, w. demolding station	For LSPc owners wanting full control, highest speeds, lowest costs

FIM Supply Chains already available



Full-service FIM injection molding incl. mold design, printing, injection molding and demolding



Full-service FIM injection molding incl. mold design, printing, injection molding and demolding



FIM focused on metal and ceramic injection molding



Mold design, fill-as-a-service, demold-as-a-service, special material and applications

User Stories



Sporting goods development,
learning accelerated

Faster failing, faster testing
enabled by FIM. FM



Packaging concept
development accelerated

You need all parts of a
product to accelerate the
product...

Personalized high-
performance orthosis enabled

Only injection molding
provided access to the right
kind of material...



Low-cost water tap
development, learning
accelerated

FIM saved 4Life from a
potential crash due to faulty
mold designs



Custom-fit earmolds mass-
produced on XiP, w. 3D-
printed molds

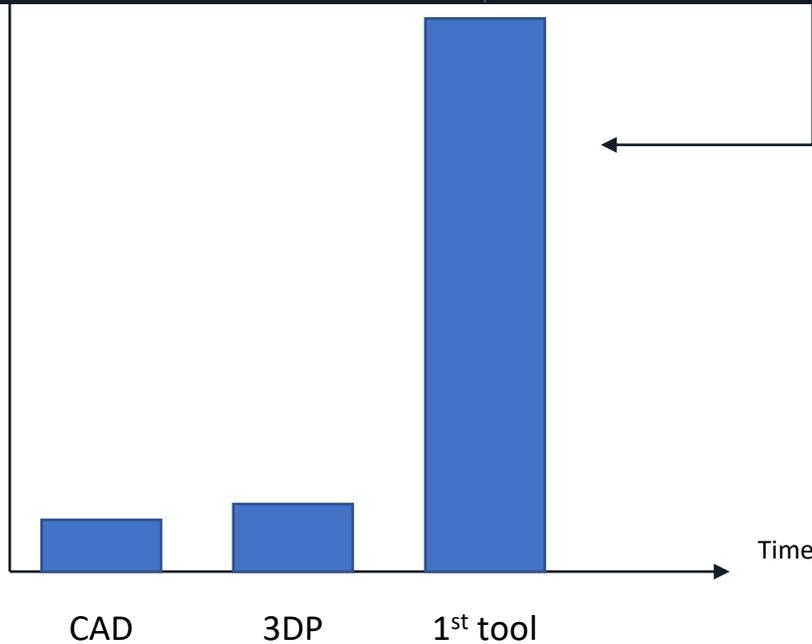
New business model enabled
by XiP superior speed and
open materials, combined
with in-depth knowledge
about printed tooling

Sustainable Development Enabled...

Conventional Product Development

Costs /
Time /
Environmental impact

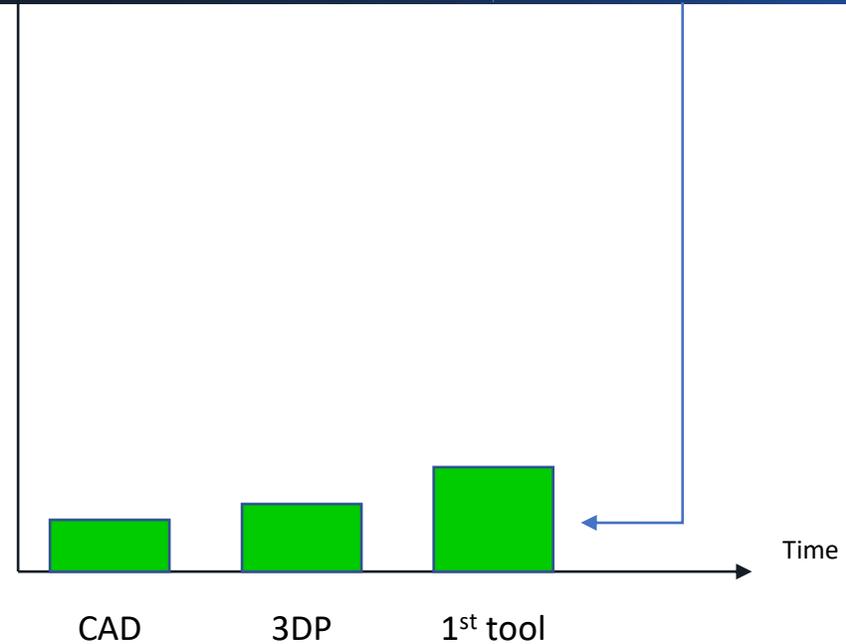
DKK 93.000
192 Work Hours
243 kg CO²



Product Development w. FIM tooling

Costs /
Time /
Environmental impact

DKK 13.600
24 Work Hours
62 kg CO²



85%
88%
75%

↓

USE CASES



Danfoss

*Ryton PPS GF40 w. Tefabloc
Overmold*

Enabling Launch-time Compression

- FIM is molded parts, 10X faster & cheaper

- **Rationale:** 10 X Faster & cheaper parts = 10x faster, 10x cheaper launch of new products, and 10 x faster and cheaper back-up manufacturing

- **Perspectives:** FIM allows manufacturers to launch and scale new products faster and with lower risk, investments while at the same time reducing the risk of out-of-stock

Conventional IM FIM

Lead-time (days)	100	10
Tooling costs (€)	25.000	2.500

Enabling Mass Customization

- FIM is Personalized Injection Molding

Rationale: Mass customization requires hyper-flexible manufacturing and high-performance materials

Perspectives: FIM allows manufacturers to build new business models based on customized, cost-efficient low-volume and single-unit productions - same day/week, with smooth transitions to scale on high-runner products



Enabling Spare Parts On Demand - FIM is Long-tail management made easy

Rationale: Spare parts should be made with the same materials and processes as the originals to avoid costly, time-consuming re-qualifications

Perspectives: FIM allows manufacturers to exploit the benefits of digital, distributed inventories without compromising on materials or design freedom



Ultramid A3EG10 PA GF50

Enabling Medical Device Manufacturing



TEKNOLOGISK
INSTITUT

Biocompatibility of
new medico products
produced by FIM

FIM allows
manufacturers to use
their already approved
materials for
prototyping and low-
volume production

Cytotox shows that
“On none of the tested
items we found cell
killing or inhibition”

Enabling Innovative Medical Devices



Cad model (left) of the silicone implant with titanium bone screw and the final porous PIST implant being tested in-vivo (right).

The Danish Technological Institute develops porous silicone implants with free form injection molding

Titanium Screws overmolded w. silicone were implanted in sheep, and recovered after 3 months.

None of the sheep exhibited any implant-related complications

Enabling Sustainability

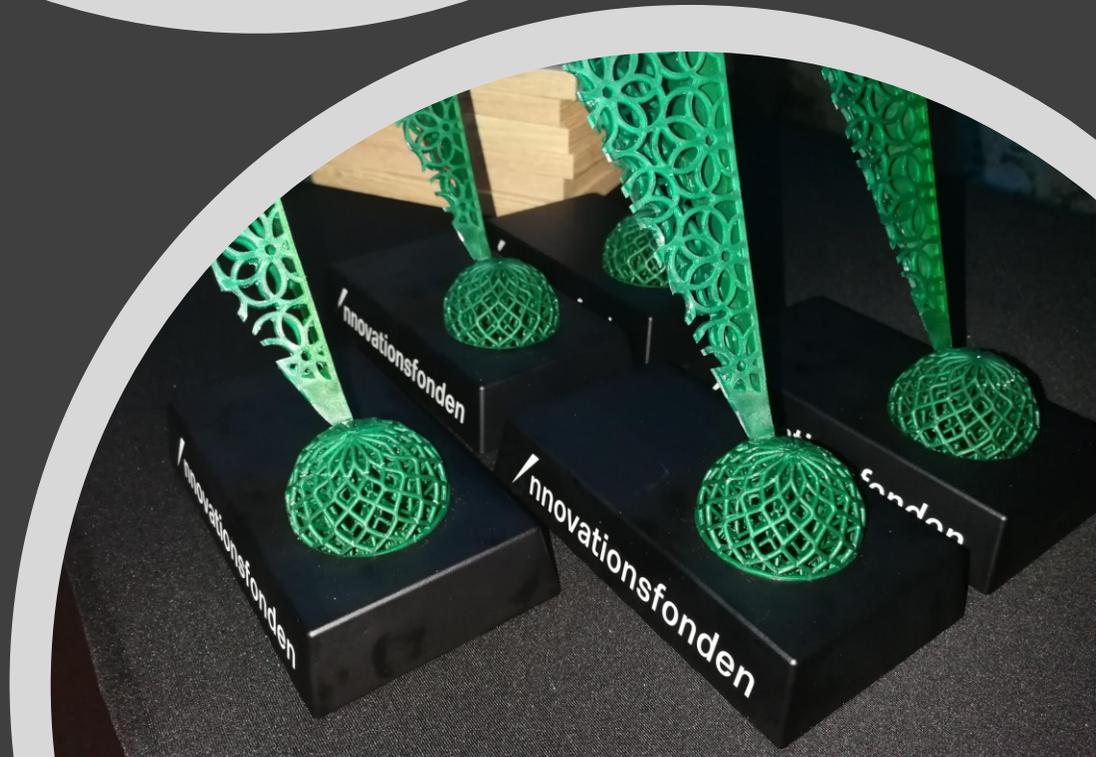
- FIM is a one-stop-shop for recycled materials

Rationale: The world is seeking ways to increase use of recycled materials and bio-materials

Perspectives: Freeform Injection Molding is a turn-key solution that allows manufacturers to speed up the implementation of sustainable materials



Recycled marine PA



Recycled marine PP

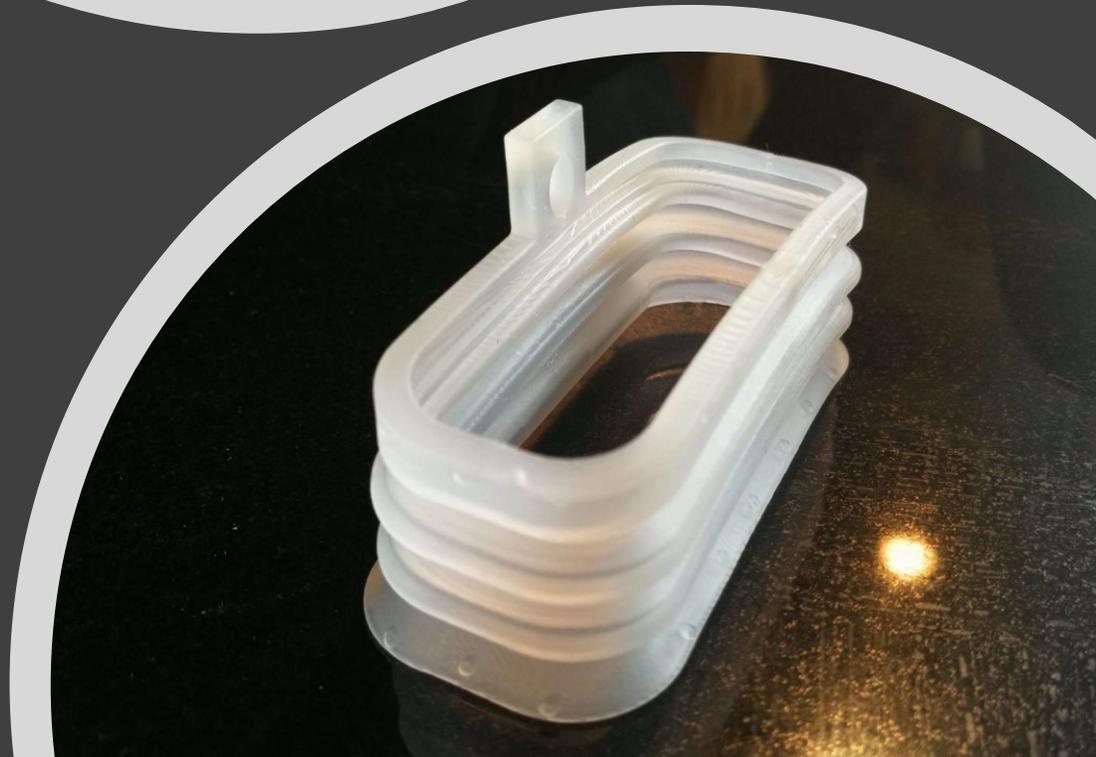
Enabling Extreme Versatility FIM covers it all – from soft rubbers to hard metals

- **Rationale:** When asked, 10 out of 10 manufacturers would want the most versatile platform
- **Impact:** With Freeform Injection Molding, manufacturers get a versatile low-volume production solution that spans the entire range of materials, from soft rubbers to hard metals

TM3MED TPE



Stainless steel 17-4PH



Enabling Lighter-weight Structures

- FIM is Generative Design with Injection Molding

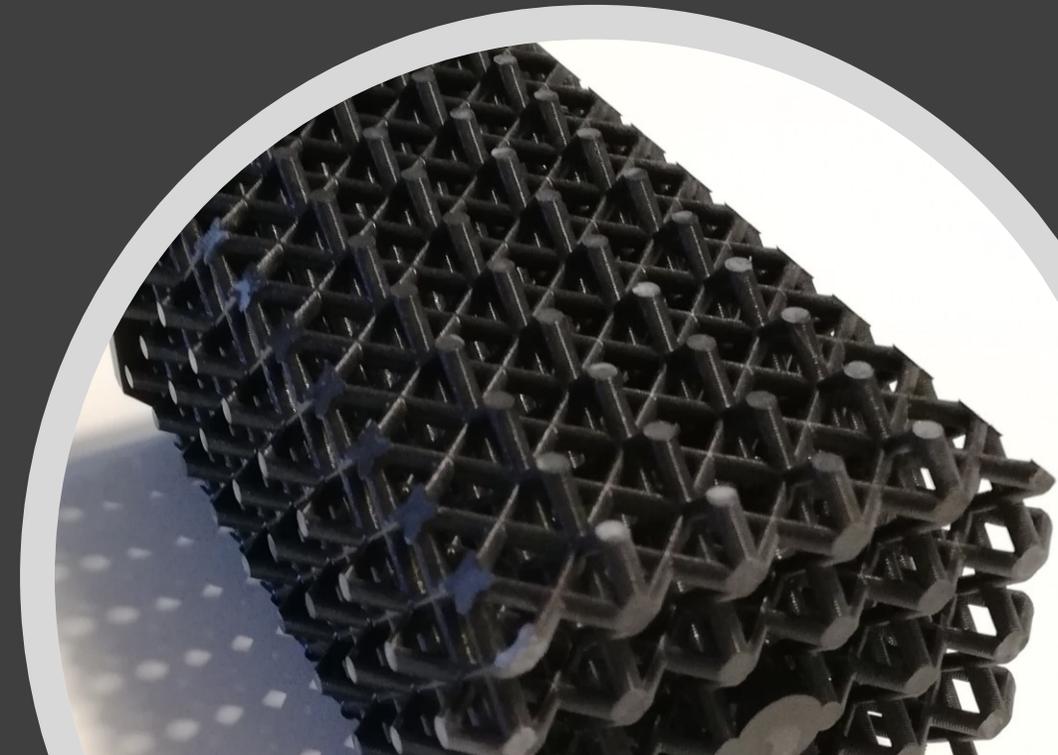
Rationale: When pursuing lightest weight, manufacturers should use the strongest materials available

Perspectives: Freeform Injection Molding allows novel parts and assemblies to be made in the highest-performing thermoplastics

See examples here:

<https://youtu.be/YG4StBQIbtE>

KyronMAX S-4230[®]



Enabling conductive polymer parts

The Reny materials from Mitsubishi Engineering-Plastics are very high-performance PA materials, and several grades are compatible with the LDS process.

Reny is also compatible with Freeform Injection Molding, which allows prototypes w. integrated circuits to be made at record speed



*Reny® XHP 1002 PA with
LDS tracks*



 Mitsubishi Engineering-Plastics Corp.



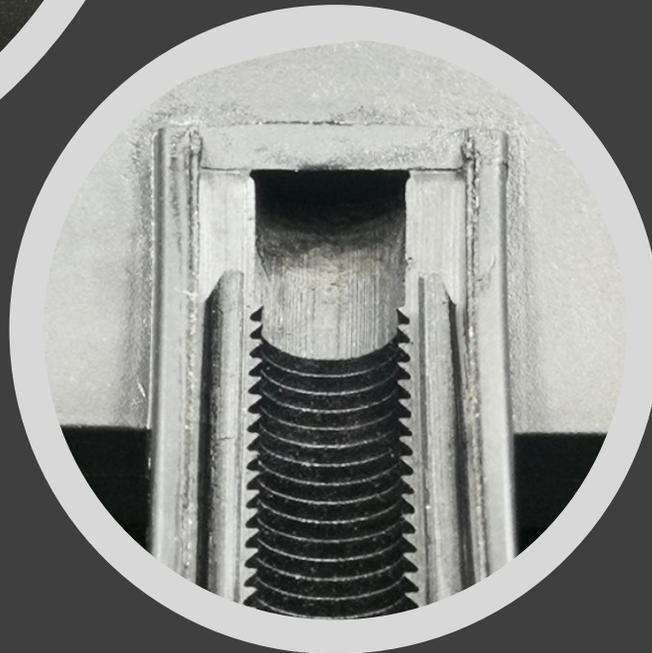
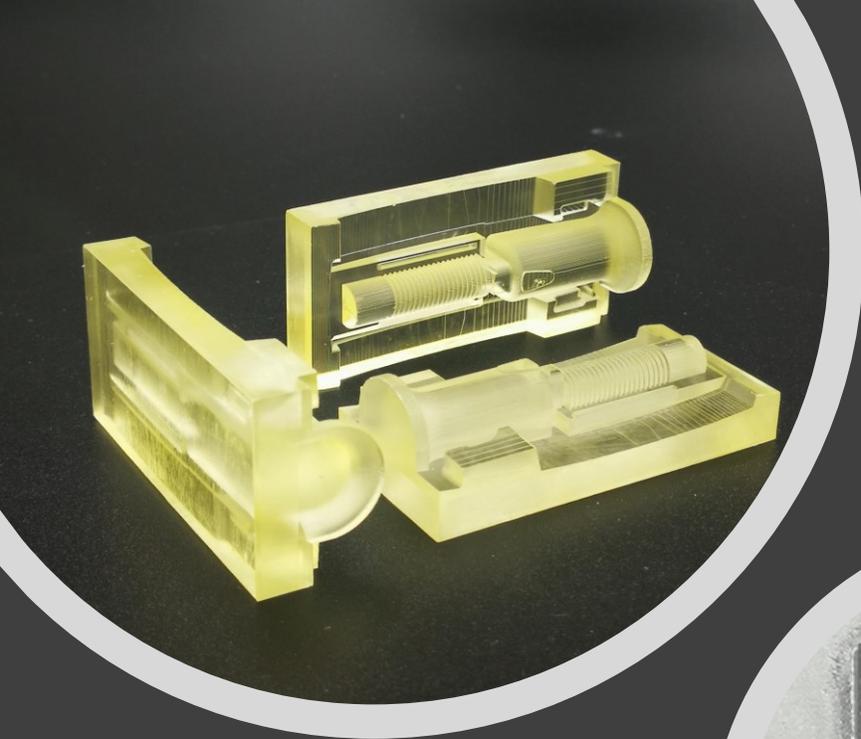
Pushing Performance

Enabling Micro Injection Molding

FIM is a powerful tool in the hands of micro injection molders wanting to fast-track their product development and their low-volume productions



Enabling Hybrid Tooling



3D-printing the entire mold cavity may not be the most efficient approach, where larger parts or more units are to be produced

FIM printed cores may be used as inserts in conventional metal cavities for unseen levels of design freedom and cost efficiency.

Case done by:



Enabling 2K-molding and insert-molding

FIM is a powerful enabler for injection-molders needing to combine materials



KyronMAX S-4230®





Enabling over- molding

FIM allows injection molders to
prototype over-molded parts as
easily as stand-alone parts

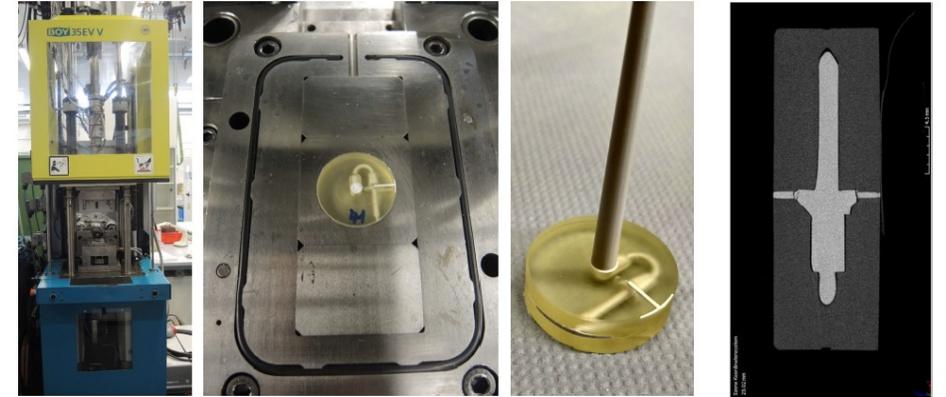
*Domamid 6LV on stainless
steel wire*

Enabling Research into New Materials

FIM is the most versatile platform available, also for researchers wanting to test and implement new materials.

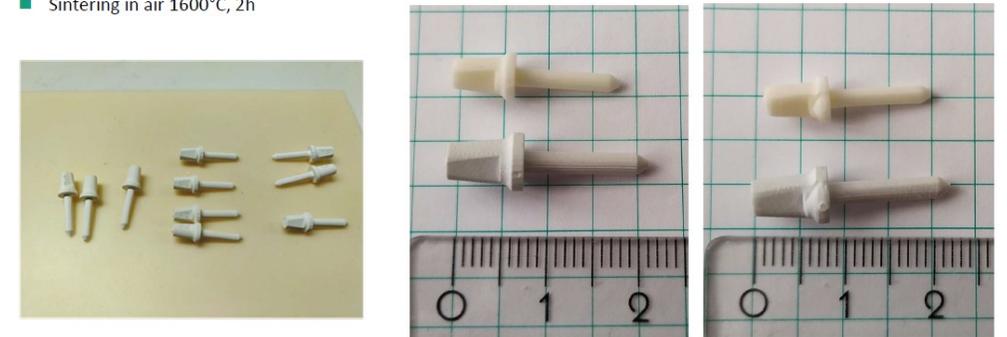
Injection Molding

- Boy 35 E VV in steel mother mold 35 mm Disk



Debinding + Sintering

- Solvent debinding in Isopropanol (75°C, 24h)
- Thermal debinding in air up to 600°C
- Sintering in air 1600°C, 2h





Questions?
- Please get in touch

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