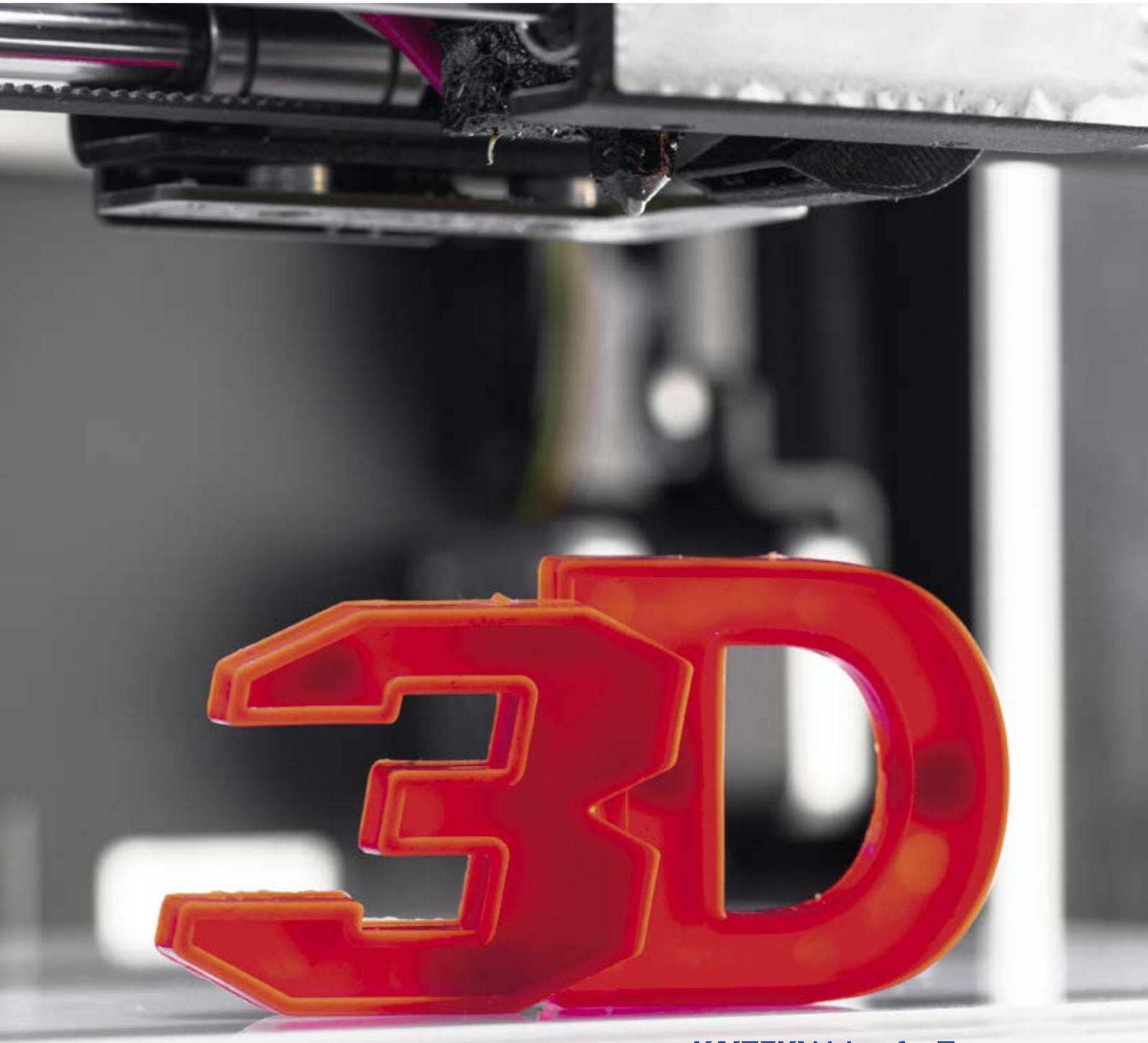


Innovative Manufacturing with 3D Printing

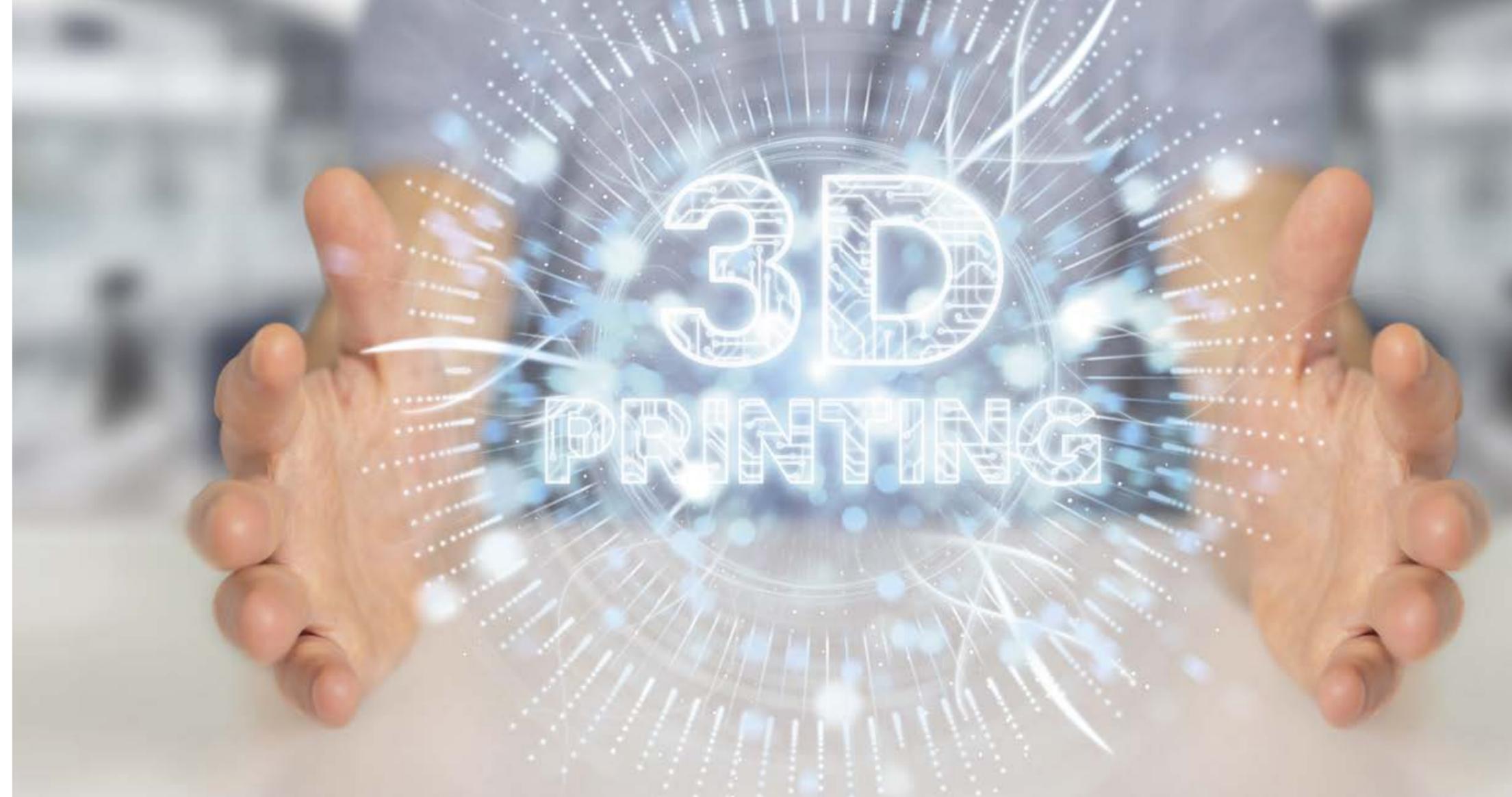
Chemicals. Materials. Technologies. Processes.



Adding Value for Engineering, Product Design, Manufacturing and Architecture.

The Mitsubishi Chemical Corporation, with its several Regional Headquarters, has the organisation and infrastructure to realise local and global synergies among the vast network of Mitsubishi Chemical affiliate companies. With over 40.000 employees at 358 affiliates in 30 different countries, Mitsubishi Chemical can now provide innovative solutions more effectively for customer applications.

Thanks to the intensified collaboration and experience, Mitsubishi Chemical group companies are uniquely positioned to meet the changing demand of key industries including automotive, aerospace, medical, packaging, building and construction and many others. Most of our industries served by highly advanced conventional production methodologies have all added 3D printing as a new extended method to manufacture in a different and beneficial way.



The quickly changing 3D printing market needs strong global partners with a sustained commitment to the 3D printing Industry. Mitsubishi Chemical is a truly global company with manufacturing facilities all over the world. Our extensive knowledge in Chemical Science in combination with our longterm strategy of further investments in 3D printing are mandatory ingredients of lasting partnerships in the 3D printing market.

Our 3D Printing commitment

Our aim is to continue to develop and extend our product offerings for the 3D Printing market.

FFF (FDM) | we started -via acquisition- and became the leading European provider of a large range of high-quality filaments and now this business has extended its success to the Americas with its own 3DP support, development and manufacturing activities. In collaboration with our FDM partners we continue to improve quality and add new materials, including biobased and biodegradable grades.

FGF | we started – via investment and development support – our partnership with Colossus 3D Pellet printing with their 20ft container size printers. Now available in a range of different FGF optimized pellets, including our worldwide known sustainable material DURABIO™.

SLA/DLP | Mitsubishi Chemical, our group companies and business partners collaborate in several joint development programs and will soon offer a range of high-performance resins designed for multiple applications.

SLS | We have started via joint development programs specific high performance SLS Powders with excellent properties and will soon offer these to our worldwide customer base.

FIM | Freeform Injection Molding makes use of 3D Printed Mold inserts ready for high precision injection molding in Mitsubishi high-performance materials. After molding the mold can be easily dissolved in water. We have started to support this technology process via investment and will show it during FORMNEXT 2019.

Partnering is at the core of our focused 3DP strategy. We welcome business partners in research, development, distribution, software applications, printing services and 3D printer technology companies. We recognise that the key to growth is a good collaboration among a network of excellent partners. Mitsubishi Chemical is planning to open a new regional innovation center to provide the best possible service for our customers.

Material developments of existing and upcoming 3DP technologies

FFF and FGF Technology

With the acquisition of Dutch Filaments, one of the world's largest polymer-based 3D filament manufacturers, the FFF and FGF technology took an important position within Mitsubishi Chemical. Since 2018, Dutch Filaments (mcpp-3dp.com) has been part of the MCPP corporation. Today MCPP operates a global network of 24 sites in 15 nations. MCPP's manufacturing plants, R&D and Sales & Technical support centers are focused on offering local and global product solutions that fit the requirements of our customers' applications.

This bridge between a 3D printing filament specialist and the polymer and compounding expertise of MCPP is tremendously enlarging the possibilities for FFF and FGF technology through a comprehensive and permanently enriched product portfolio.

MCPP has a broad portfolio of 3D printing materials. For example, materials such as DURABIO™ and 3Diakon™ from Mitsubishi Chemical are just launched on the market. MCPP is constantly developing and innovating to expand their wide and unique product portfolio. Besides the own range of MCPP's 3D printing filaments MCPP also offer toll manufacturing for industrial clients and is specialized in producing filaments according to their requirements. MCPP also offers private label filament solutions. Every customer can create their own brand of filaments.

Partnerships with chemical companies show the unique position of MCPP in the different markets. Within the Mitsubishi Chemical group, the knowledge of polymers is wide. Partnering up with such companies as DSM gives MCPP the possibility to expand their knowledge and to support chemical companies in tailored ways.

If we look at the current status of the market, we see that the FGF market is still an upcoming technology compared to the market of FFF. We believe big printing gives a lot of opportunities for applications such as furniture, buildings and many more. The only option to take a position in this market is to work together with printer manufacturers for different applications. The total package of requirements of the final application is the core knowledge needed to start successful projects. Different partnerships like we have with Colossus clarify our objective to collect more knowledge about this technique to reach our main goal:

'To help the market finding the right solution for their application and supporting them with producing the right material.'



DURABIO™ Bio-Based Engineering Plastic

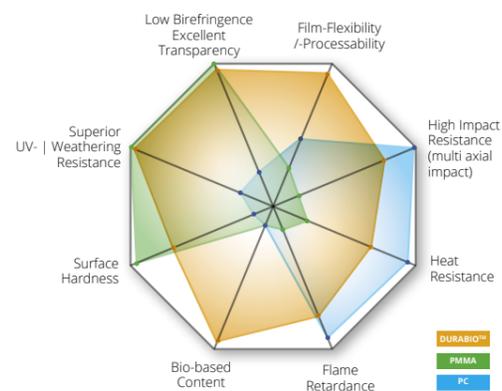
Mitsubishi Chemical's DURABIO™ bio-based material is a truly durable engineering plastic that is made from isosorbide (derived from sorbitol), a widely available feedstock. In addition to being environmentally friendly, DURABIO™ material also combines most of the advantageous properties of Polycarbonate (PC) and those of the Polymethyl methacrylate (PMMA), creating an innovative renewable material with extraordinary properties.

DURABIO™ is particularly designed for scratch and impact resistance applications requiring exceptional durable transparency and visual appearance, such as:

- Touch screen displays
- Optical features: high transparency, low birefringence
- Interior automotive console and IP trim
- Exterior automotive grills, pillar panels and trim
- Sporting equipment: crystal clear lenses
- Aerospace: light pipes inside the cabin

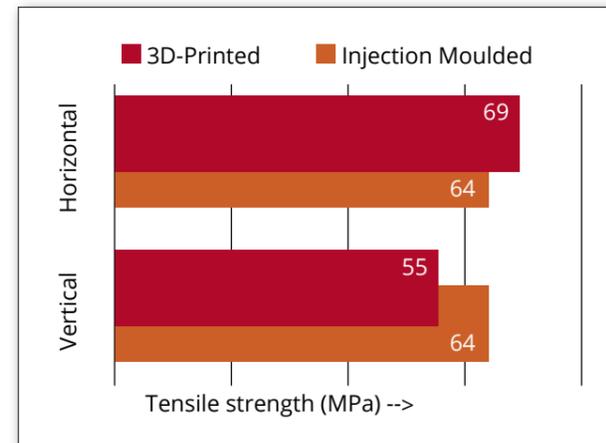
Key Features

- Partly bio-based
- High surface impact strength
- UV/Weather resistant – Ensures long life of products, saving resources
- Paint-free/Coating-free finish – Reduction of VOCs, lower carbon footprint as well as increased production efficiency
- Abrasion resistant – Ensures intact aesthetics over many years of usage
- High optical transmission – Used as glass replacement, further reducing product weight



DURABIO™ – Comparison vs. PMMA and PC

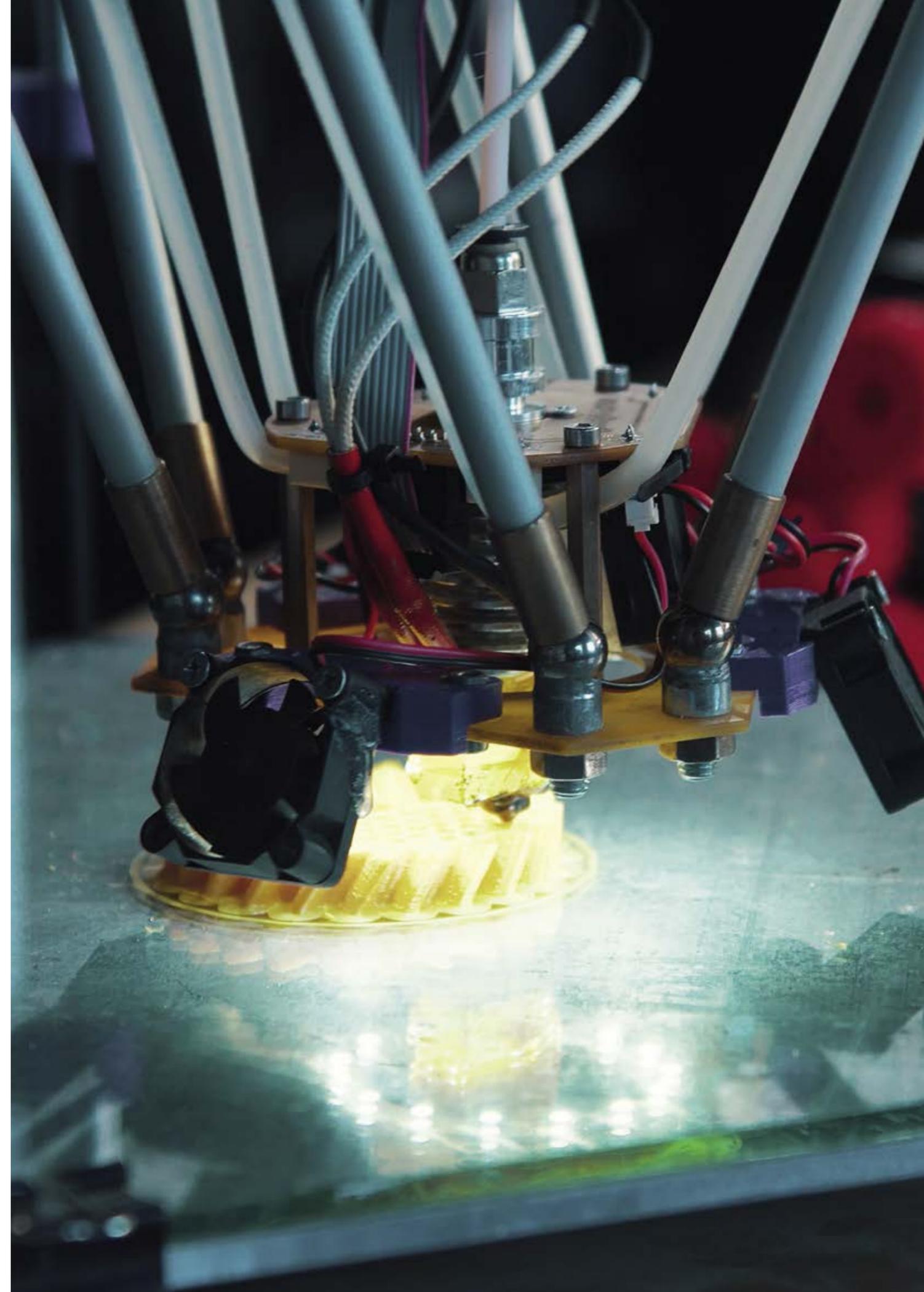
DURABIO™ performs well when 3D printed. To be able to define optimized settings for DURABIO™ we tested the influence of different parameters on the strength and interlayer adhesion for vertical tensile bars.

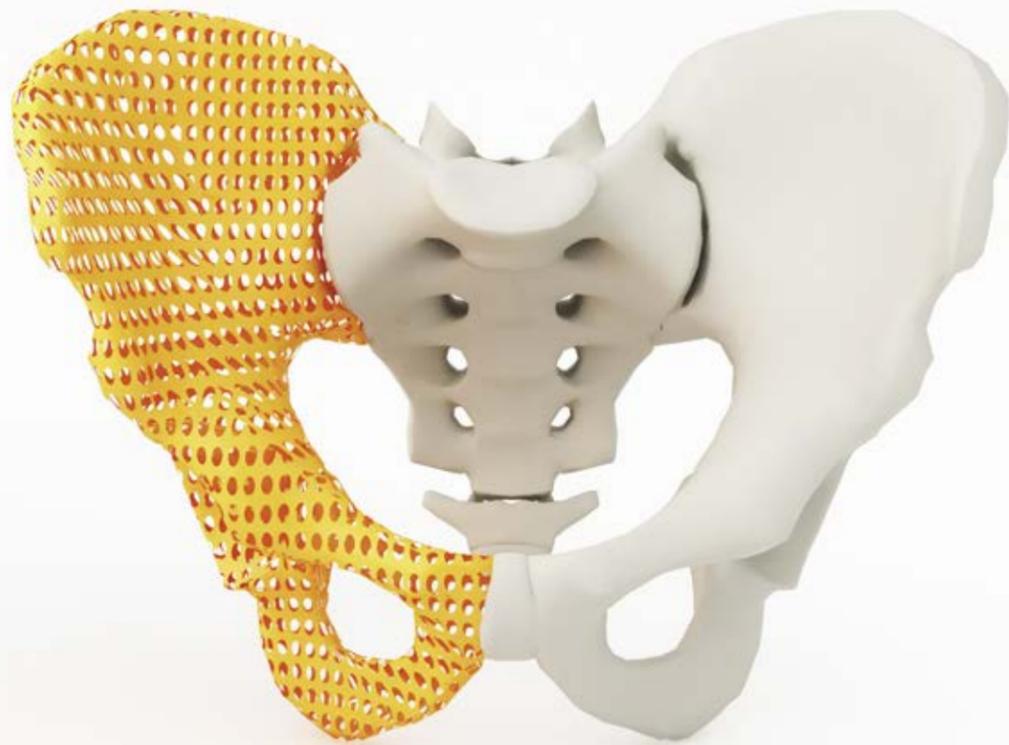


The strength of the 3D-printed objects in the direction of the layers improved by 8 MPa which means that the performance of the horizontal specimens is higher than that of the injection molded specimens.

Major improvements have been made in the strength in the vertical direction. The strength achieved is 86% of the injection molded specimens compared to the 28% achieved when using the base profile created via the MCPP Testing Methodology.

MCPP is constantly testing materials which gives them better understandings of the behaviour of different materials vs the 3D printing process. Besides the fact that it is a unique selling point to provide this information to customers, it also gives a lot of knowledge about the behaviour of different polymers.





SLA/DLP

Historically, Mitsubishi Chemical has a long history in the development and sale of UV resins, especially UV curable coating resins such as hard coats, under coats and so on. We are very enthusiastic to use this knowledge to develop SLA/DLP resins by offering characteristic raw materials to many global partners.

Furthermore, by using these raw materials, the development of unique UV resins with partners is also being advanced, aimed at delivering higher performance. By using our knowledge, we can advance the material development for specific applications with our partners and create better material-machine solutions for industrial applications, for example in cooperation with DLP printer partner Atum3D from the Netherlands.

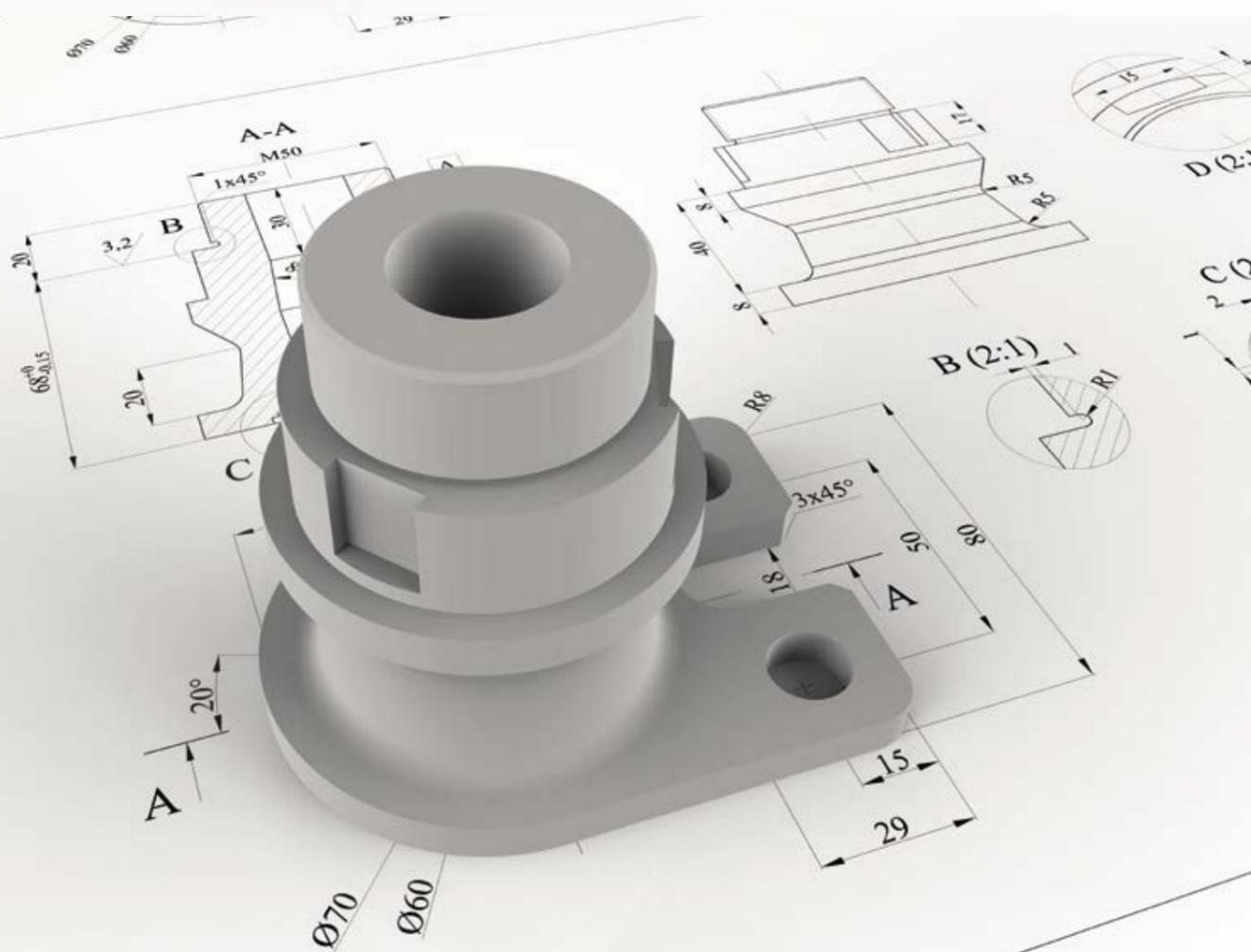


SLS

Mitsubishi Chemical has developed a high-performance engineering plastic powder for 3D printing. By using our unique polymerization technology, NOVADURAN®, a PBT resin supplied by Mitsubishi Engineering Plastics has been modified for powder-based 3D printers. NOVADURAN® has many unique features such as high mechanical strength, electrical insulation, chemical resistance, dimensional stability for molding and lower water absorption. Hence it is well suited to the mobility and home applications and more.

Mitsubishi Chemical is very keen on developing 3DP powders for specific applications with global partners, combining their own expertise of the 3DP process together with our deep knowledge of polymers development and compounding process. Indeed, it creates possibilities to push boundaries such like providing additional functions to our PBT powder, like flame retardance and fiber reinforcement.

We foresee a growing huge interest for powder 3DP technologies, and Mitsubishi Chemical is actively investigating the market in order to develop new types of high-performance powder suitable for specific applications, with a special focus on high demanding ones.





Materials. Machines. Applications. Services.

Our strategy is not only to develop basic chemicals and polymers (liquid, pellets, powder) but to offer business partners a wide variety of filaments with different material characteristics to support diverse applications. Mitsubishi Chemical's Advanced Polymer Business Domain is coordinating and taking leadership in the area of 3DP materials on a global basis. Furthermore, we will continue to invest and develop in several business partners in the fields of 3DP machines, 3DP applications and 3DP services. Strong collaboration with business partners is necessary to enable us to work at speed in the fast changing 3DP markets.



Partnerships.

Mitsubishi Chemical looks for future 3DP technology partnerships that can contribute to the growing opportunities in 3DP manufacturing. We see it as a method of manufacturing which can be disruptive in many ways and is highly efficient at the same time. This fits to our Vision "Realizing KAITEKI". The sustainable well-being of people, society and our planet Earth – we call it KAITEKI.



Research and Development.

We can now combine our teams in molecular and functional design technologies and utilize our special knowledge of analysis, synthesis of inorganic and organic polymers, mechanical design and control engineering, product evaluation and safety evaluation and simulation.

In doing so, we embrace innovation and work closely with our customers and business partners to support the fast-changing market demands in all industries. This is especially true with 3D printing where we are increasingly receiving requests through our different Business Domains and a wide area of industries for our special materials.



Freeform Injection Molding (FIM)

Merging additive manufacturing and injection molding for superior scalability and an unprecedented selection of materials, FIM is a new part of the Mitsubishi ecosystem: An additive platform that blends the best from 3D printing with the scalability and versatility of injection molding. Using FIM, injection molders may process the entire range of high-performance Mitsubishi Chemical materials, with the short lead-times, low start-up costs and extensive design freedom known from 3D printing.

Designers and manufacturers may dramatically shorten times-to-value by adopting the FIM approach. They may offer their customers an unheard-of freedom to scale or to customize. They may offer lower-than ever lifecycle costs.

FIM reflects the Mitsubishi Chemical dedication to the 3D printing community: To support the world of 3D Printing with a fully integrated and independent supply chain. The tried and trusted materials from the DIAKON™, KETRON™, TEFABLOC and KYRONMAX™ programs turn additive, enabled by Freeform Injection Molding. Building the platform of tomorrow, by delivering value already today, with FIM.



PMMA

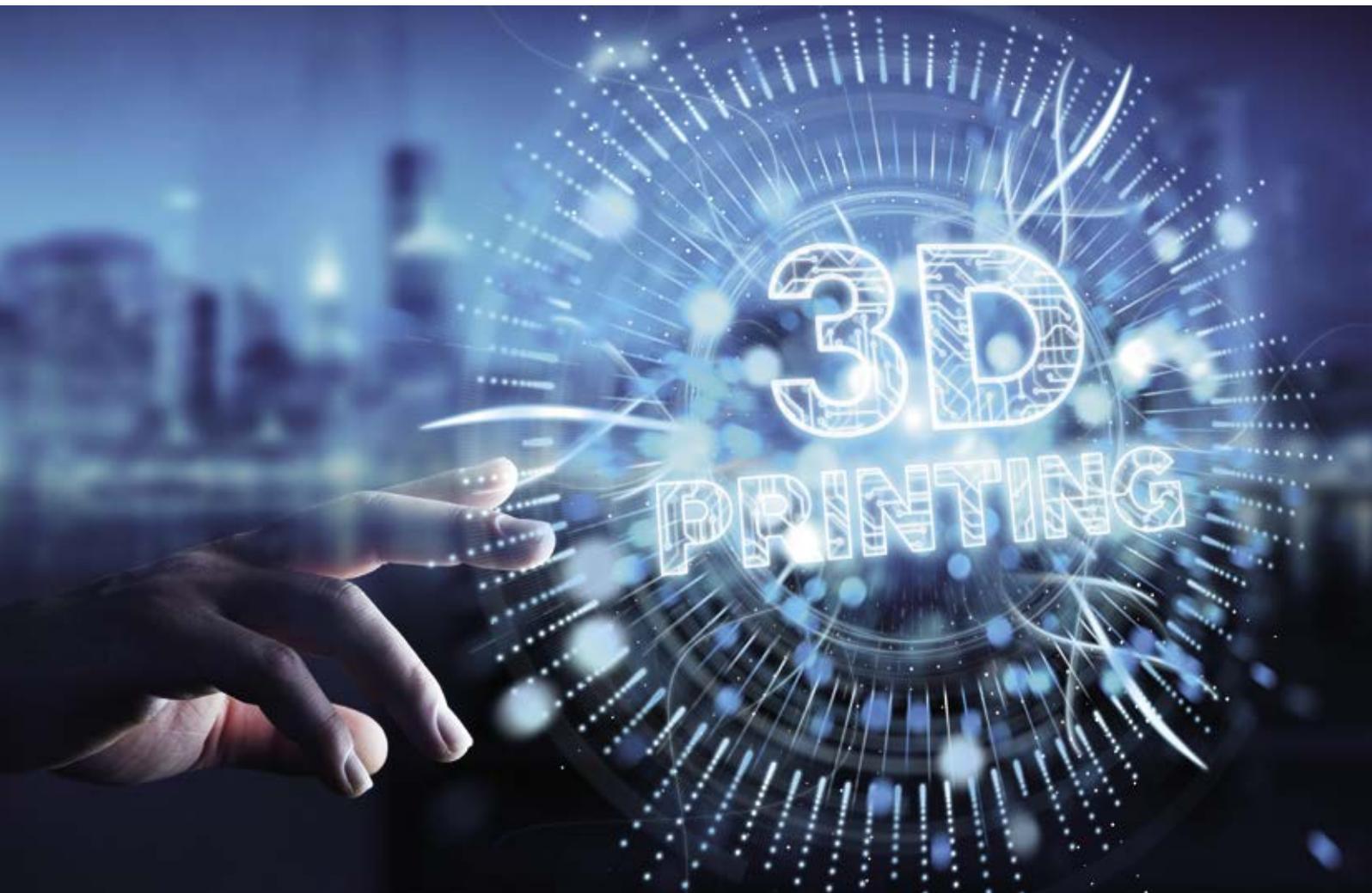


Tefabloc™



PEEK

Supporting the world of 3D Printing with a
fully integrated and independent supply chain



Mitsubishi Chemical Corporation
www.m-chemical.co.jp

KAITEKI Value for Tomorrow

Mitsubishi Chemical Holdings Group

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