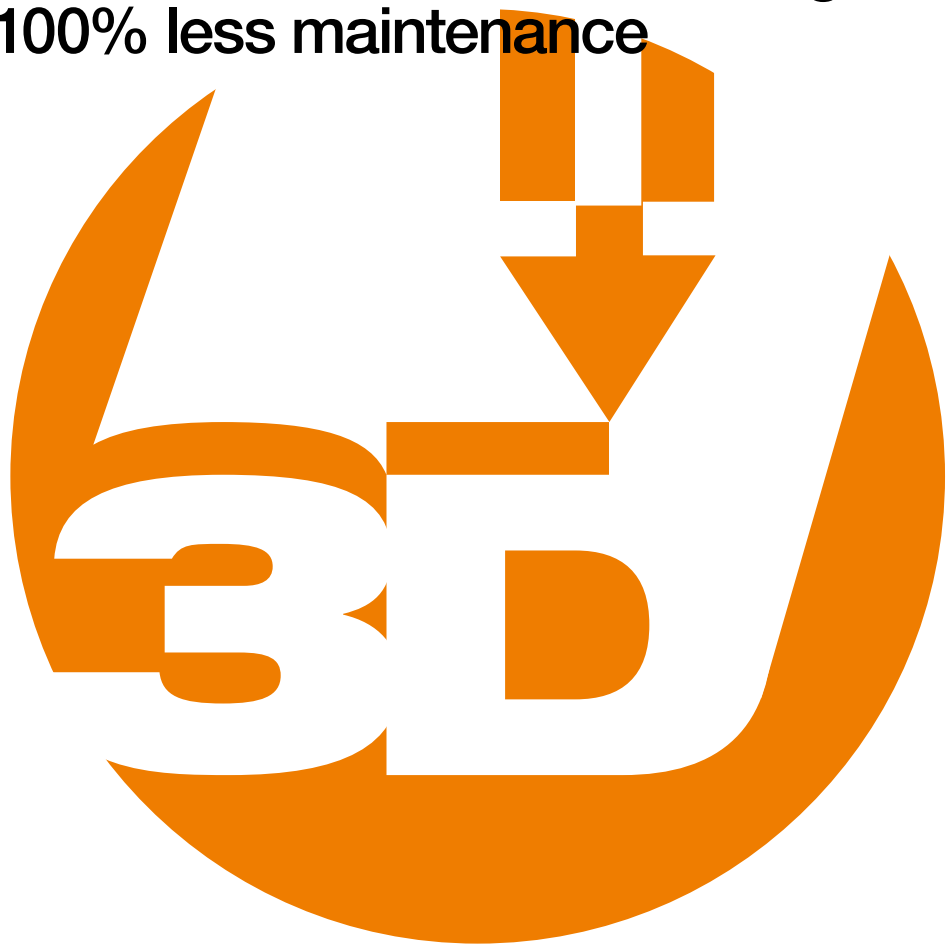


3D printing

Solutions for 3D printing
40% less costs, 80% less weight,
100% less maintenance



• plastics for longer life®

igus®.eu...

www.igus.eu/tribo-printing

100% lubrication-free, from the bearing surface to the printed product



Your technical innovator and cost reducer,
Michael Hornung

Product Manager
drylin® linear and drive technology
Phone: +49-2203 9649-156
e-mail: mhornung@igus.de
www.igus.eu/3d-print

Your technical innovator and cost reducer,
Tom Krause

Head of Business Unit
Additive manufacturing
Phone: +49-2203 9649-975
e-mail: tkrause@igus.de
www.igus.eu/tribo-printing

Lubrication-free printing and lubrication-free bearing solutions. Maximum 3D printing freedom thanks to the large igus® motion plastics® system.

Lubrication-free printing.

Abrasion and wear-resistant tribo plastics for additive manufacturing via selective laser sintering (SLS) or the use of filament (FDM/FFF) allow you to use the printed bearing or to test the function of the part reliably and completely from the prototype or production batch onward.

Lubrication-free bearings.

Through the use of igus® high-performance plastics, 3D printers and scanners are maintenance-free and operate without lubrication. drylin® linear plain bearings are silent because they do not use metal balls; dryspin® lead screw nuts adjust the print bed efficiently and precisely; igus® energy chains® prevent cable malfunctions and extend machine operating times.

Our online tools also enable you to reduce process costs. Visit our industry website www.igus.eu/3d-print or test our 3D printing service www.igus.eu/3dprint-service.

Draw inspiration from the ideas and solutions in this brochure.



Print to mould:
series production of the first printed lead screw module starts - prototype of the drylin® SLTP made of iglidur® I3 printed ... savings now possible thanks to injection moulding.

www.igus.eu/3d-print

motion? plastics! – Our drive? Plastic!

motion? plastics! Tribologically optimised machine parts made of plastic for all kinds of movements.

Our slogan can be translated thus. We have been pursuing this idea passionately for more than 50 years. Plastic is light, robust, cost-effective and has low friction. Maintenance? Equal to zero, because our products are without any additional lubrication, show little wear and hardly cause downtimes. We make precise service life prediction with our online tools - simply enter the technical data of your particular application.

Ultra-smooth dry operation.

It all sounds very easy but, in fact, it is the result of a great deal of intensive work. Plastics must possess some very specific properties so that they can operate smoothly without any lubrication. We created them with the help of tribology, i.e. the study of friction, analysing the wear and friction characteristics of plastics, combining different polymers with each other and then testing the resulting products for their practicability. What we ended up with were "tribo-optimised" high-performance plastics - low-friction, resilient and long-lasting materials that make your machines more reliable and efficient. In our catalogue, there are more than 50 different plastics to choose from, 16 of which we offer as part of our full range of products.

Technical design without limits.

"Greater design freedom and flexibility" - what company founder Günter Blase succinctly pointed out as a fundamental ideal in the 1960s has now taken on a clear form after five decades of hard work: more than 100,000 modular and configurable products are currently supplied by igus® for technical designs without limits: energy chain systems® and matching cables, plastic, linear and spherical bearings, lead screw units, ball bearings, linear drive technology, bar stock, materials for 3D printing, liners as well as components for low-cost robotics.

Convenient. Long life. Predictable.

To make life easier for users, all igus® components can be conveniently ordered in the online shop. There is no minimum order quantity and the goods will be sent to you with a short lead time. A further service: with the igus® online calculating tools, you can calculate the service life of your chosen component in your actual application. This is based on the data that we obtain in innumerable test cycles in the igus® test laboratory.



The 1965 idea:
"Show me the plastic part that gives you a problem. I'll provide you with a solution!"

igus® research and test laboratory on a floor area of 2,750 square metres.



Conversion of festoon to igus® energy chain system® at MVA Weisweiler. It has been running "round" 24/7 for more than six years.



Change from ball bearings to igus® drylin® linear bearings. With drylin®, the machine has now been operating completely trouble-free for many years under the toughest conditions.



www.igus.eu/3d-print

Printed, injection-moulded, machined - with tribologically identical properties

Tribo parts, created easily according to your needs: everything a question of quantity.

With around 100 different materials for very different environments, igus® now offers the largest selection of tribo-enhanced plastics. igus® also offers the most common methods of processing Tribo plastics such as 3D printing, extrusion or injection-moulding. As a result, the design engineer always has the right quantity of the right parts in each phase of his project development work.

Advantages of igus® products in 3D printing:

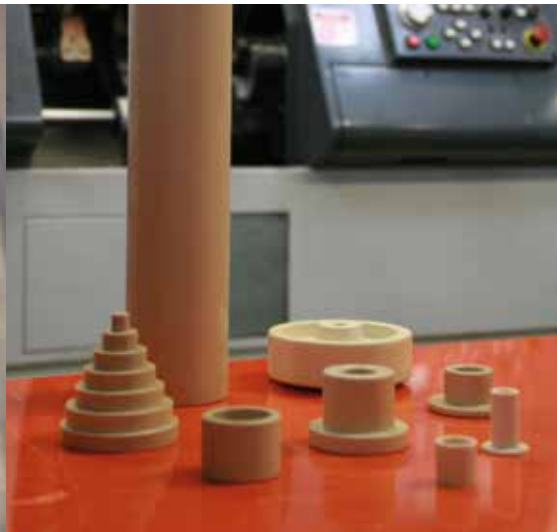
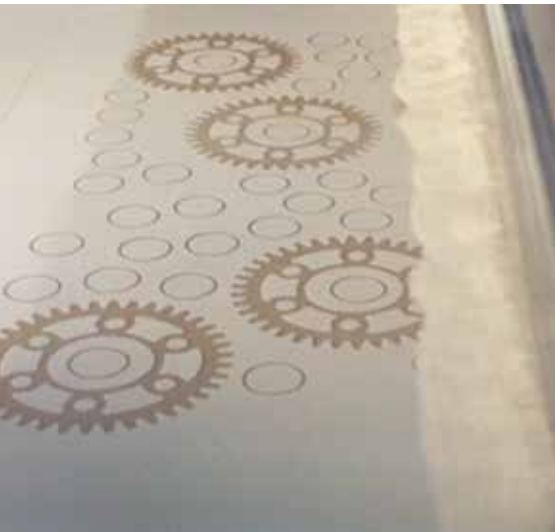
- Lubrication-free
- Silent operation and smooth sliding
- Resistance to dirt
- Long service life
- Corrosion-resistant
- A wide array of variants and material types
- Delivery from stock, from batch size 1 in as little as 24h



The print head layers the plastic filaments on the print table. Dry-running drylin® R linear bearings ensure accurate travel.

www.igus.eu/3d-print

From prototypes and very small quantities to small series and serial production



3D printing / SLS

For prototypes or small quantities made from tribo-filaments with the laser sintering method

Wear-resistant materials for 3D printing and the laser sintering method - print parts yourself or have igus® print them for you.

- Up to 50 times more abrasion-resistant than conventional 3D print materials
- Various iglidur® materials available for FDM/FFF, iglidur® (filament) and SLS (powder)
- No tool costs; cost-effective from batch size 1

Machined/turned

From small series made of iglidur® bar stock

For greater designing freedom: bar stock for doing it yourself or supplied immediately as your finished part.

- As round bar in Ø 10-100 mm
- Lengths 100-1,000 mm
- As plate material in thickness 2-40 mm

Printed tools

For small quantities made from iglidur® granules

3D-printed injection mould tools. Bearing parts with a simple geometry can be made from most iglidur® materials.

- Customised parts delivered from 72 hrs
- Up to 80% more cost-effective than conventional injection mould tools
- For prototypes and small volumes

Injection moulding

For serial production of items made of iglidur® granules

Modern injection-moulding systems enable the low-cost, controlled manufacture of standard and special parts.

- Can be ordered and calculated online
- 100,000 products from stock

3D printing with tribo-filaments: 50 times more abrasion-resistant for maximum service life

Components made of igus® tribo-filament are up to 50 times more wear-resistant than standard materials for 3D printing and therefore have an extremely long service life. Due to their excellent tribological properties, they are suited for 3D printing of replacement parts for e.g. bearings, drive nuts, gears and other parts.

The igus® Tribo-Filaments can be processed on 3D printers that are based on the fused-deposition-modelling method (FDM/FFF) and that allow the nozzle temperature to be set as required.



Material: iglidur® I150-PF

Wearing parts printed the easy way

- High abrasion resistance at low speeds
- Good mechanical properties
- The easiest to process tribo-filament (even without a heated print bed)
- Nozzle temperature: 240 - 250 °C

Material: iglidur® I180-PF / I180-PF-BL
Best combination of machinability and service life

- High abrasion resistance
- Good mechanical properties
- Nozzle temperature: 250 - 260 °C
- Also in black (igidur® I180-PF-BL)



Material: iglidur® J260-PF

Extremely long service life and excellent coefficients of friction

- Outstanding abrasion resistance of tribo-filaments
- Application temperature from -100 °C to +120 °C
- High-quality processing
- Nozzle temperature: 260 - 280 °C



Material: iglidur® C210-PF

For printing products that are resistant to chemicals and highly abrasion-resistant

- High chemical resistance
- High abrasion resistance
- High-quality processing
- Nozzle temperature: 260 - 270 °C

Material: iglidur® I170-PF

Longer service life

- Improved abrasion-resistance
- High-quality processing
- Nozzle temperature: 240 - 260 °C



The right iglidur® filament for your application



"How do I assess myself and my 3D printer?"

Ambient temperature of application	Beginner "Nothing can go wrong"	Advanced "Everything is usually ok"	Expert "I know what I am doing"
-30 to +65 °C	igidur® I150	igidur® I150 igidur® I180	igidur® I180 igidur® J260 igidur® I170 igidur® I180
-40 to +80 °C	igidur® I180	igidur® I180	igidur® J260 igidur® I170
-30 to +100 °C			igidur® J260 igidur® C210
-100 to +120 °C			igidur® J260

Processing instructions

igidur® tribo-filaments can be processed on any 3D printer that is equipped with a heated print bed on which temperatures are adjustable. The igus® adhesive film allows a good adhesion between the iglidur® tribo-filament and the print bed. Further recommended printing surfaces are "Buildtak" or "Blue-Tape" with glue applied "Pritt Power" stick.

- Good ventilation should be provided during processing
- When heated above +300 °C, hazardous fumes are produced



Example Part No. tribo-filaments **I150-PF-0175-0250** for 250 g spool with a diameter of 1.75 mm made of iglidur® I150



www.igus.eu/tribofilament

Thanks to the film available from igus® for the print bed, there is very good adhesion between the iglidur® tribo-filament and the print bed.

- Useable up to approx. 20 times
- "Set" the degree of adhesion by means of print bed temperature
- 3D printer without heating bed? The combination of iglidur® with this print bed film also makes it possible to make wearing parts oneself with such 3D printers

igus® print bed film for your print bed



Part No. adhesive film for print bed
PF-01-0203-0203 (203 x 203 mm)
PF-01-0254-0228 (254 x 228 mm)



Spool

igidur® tribo-filaments weighing 250 g are wound onto a spool with an outer diameter of 105 mm, a width of 55 mm. It has an inner diameter of 55 mm. Test kits with 25 g filament are also available; this is not wound onto a spool.



Example Part No. test kits **I150-PF-0175-0025** for 25 g filament, loose, with a diameter of 1.75 mm made of iglidur® I150

Filament thickness

The iglidur® tribo-filaments are available with 1.75 mm and 3 mm thickness. The 3 mm filaments can be used without problems in 3D printers that need a 2.85 mm filament.



3x more material

With the bigger spool size, each spool contains 750 g filament (300 m filament in 1.75 mm diameter or 90 m filament in 3 mm diameter).

Tribo plastics for laser sintering - designing in 3D with iglidur® I3

Tested! The material iglidur® I3, specially developed for laser sintering, proved to have an abrasion resistance at least three times higher than conventional materials for laser sintering during tribological tests in the igus® test laboratory. This means the degree of design freedom for wear-resistant parts has been further increased.

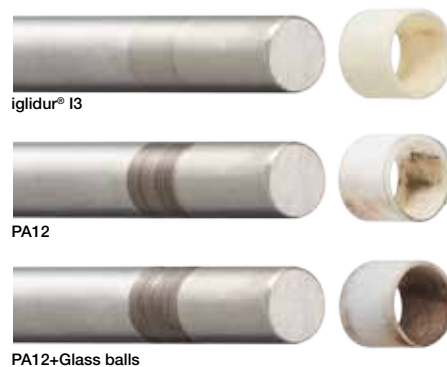
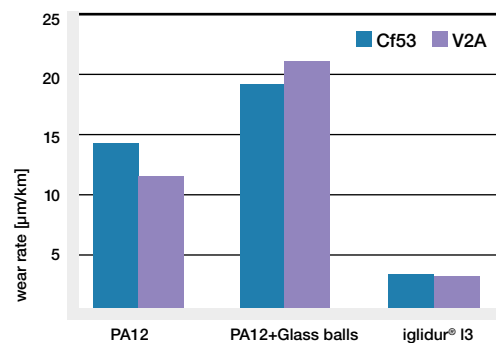
- Wear-resistant
- Good mechanical properties
- Detail accuracy with exact surfaces
- Can be processed using the standard parameter set
- Refresh rate: 75%

www.igus.eu/laser-sintering

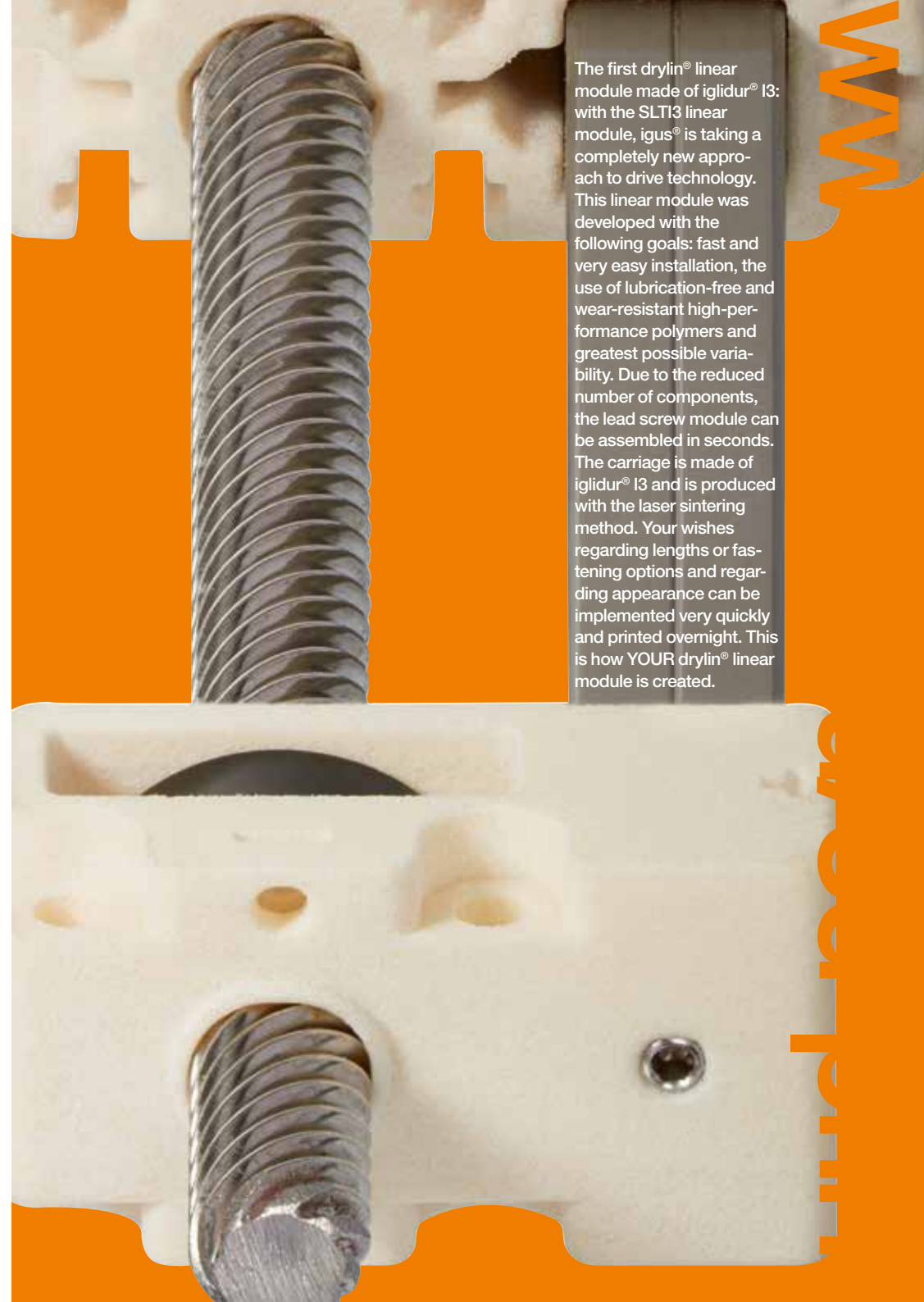


Wear, rotating

$v = 0.3 \text{ m/s}$ $p = 1 \text{ MPa}$



In this wear test, the abrasion resistance of iglidur® I3 is higher than that of conventional SLS materials by a factor of approximately 4. The shafts and bearings that are shown and were used in the test make it clear that iglidur® I3 results in considerably less stress on the counter partner, the service life of which is also increased as a result.



The first drylin® linear module made of iglidur® I3: with the SLT13 linear module, igus® is taking a completely new approach to drive technology. This linear module was developed with the following goals: fast and very easy installation, the use of lubrication-free and wear-resistant high-performance polymers and greatest possible variability. Due to the reduced number of components, the lead screw module can be assembled in seconds. The carriage is made of iglidur® I3 and is produced with the laser sintering method. Your wishes regarding lengths or fastening options and regarding appearance can be implemented very quickly and printed overnight. This is how YOUR drylin® linear module is created.

iglidur® J260 tribo-filament: printed as good as injection- moulded, tested thousands of times

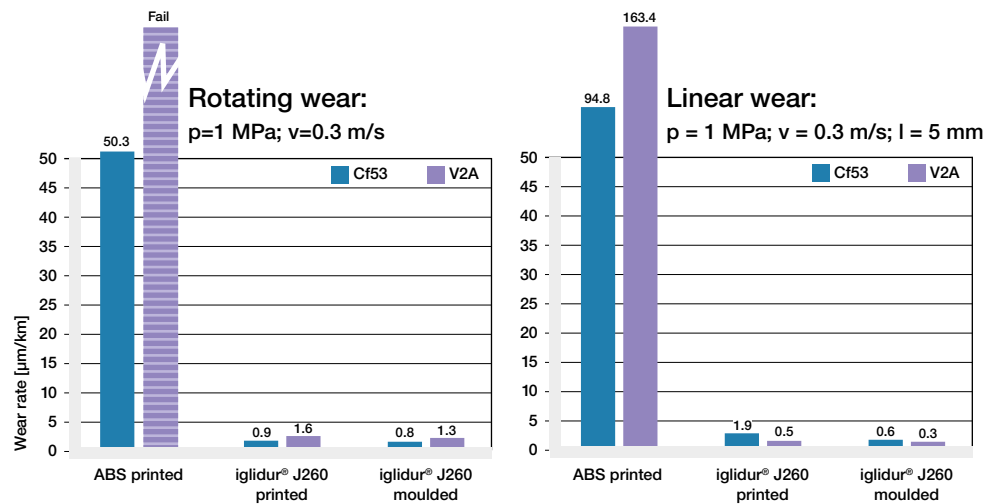
3D print filament impresses during tests with injection moulding quality

Our iglidur® J260 tribo-filament is more wear-resistant than standard print material

Our series of tests show: printed plain bearings from our latest filament iglidur® J260 are equally as wear-resistant as our injection-moulded parts from the same material. The tests have also proven that iglidur® 3D print filaments have considerably lower coefficients of friction and are up to 50 times more abrasion-resistant than conventional 3D printing materials.

This makes iglidur® tribo-filaments the only 3D printing materials to also offer impressive performance in moving applications. You can therefore directly install printed parts such as bearings, drive nuts or worm gears and use them as parts - from the prototype phase to series production.

- Outstanding abrasion resistance of tribo-filaments
- Application temperature from -100 °C to +120 °C
- High-quality processing
- Available as filament, bar stock or injection-moulded part - from the prototype of series production



Tribo sensation:
iglidur® J260-PF filament



Better products for less - a key element is the industry's largest test lab. 2,750 square meter lab, more than 15,000 tests and 2 billion test strokes per year.

www.igus.eu/3d-print

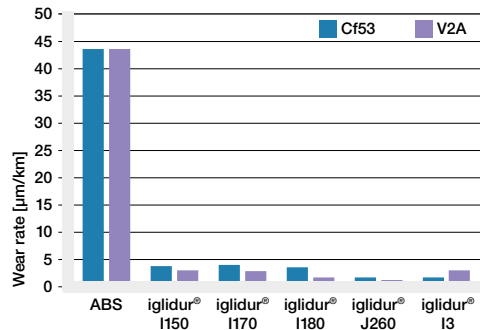
tribo-filaments - material properties and tests

Material properties		iglidur®				
General properties	Unit	I150	I180	J260	I170	C210
Density	g/cm³	1.30	1.21	1.35	1.21	1.40
Colour		white	white	yellow	yellow	white
Max. moisture absorption at +23 °C and 50 %r.h.	% weight	0.3	0.3	0.2	0.5	0.3
Max. water absorption	% weight	0.7	0.9	0.4	1.6	0.7
Mechanical properties						
Flexural modulus	MPa	1,700	1,000	1,000	1,000	1,600
Tensile strength at +20 °C	MPa	54/37 ¹⁾	46/33 ¹⁾	41/13 ¹⁾	33/17 ¹⁾	38/30 ¹⁾
Shore-D hardness		62	66	66	64	70
Physical and thermal properties						
Max. long-term application temperature	°C	+65	+80	+120	+75	+100
Max. short-term application temperature	°C	+75	+90	+140	+85	+180
Min. long-term application temperature	°C	-30	-40	-100	-40	-30
Electrical properties						
Specific contact resistance	Ωcm	> 10 ¹³	> 10 ¹²	> 10 ¹²	> 10 ¹²	> 10 ¹³
Surface resistance	Ω	> 10 ¹²	> 10 ¹¹	> 10 ¹⁰	> 10 ¹¹	> 10 ¹²

¹⁾ Printed flat/upright

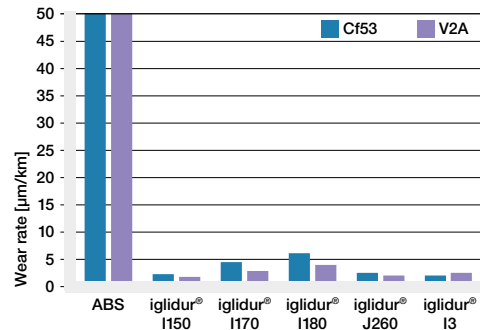
Wear, pivoting

p = 1 MPa, v = 0.01 m/s



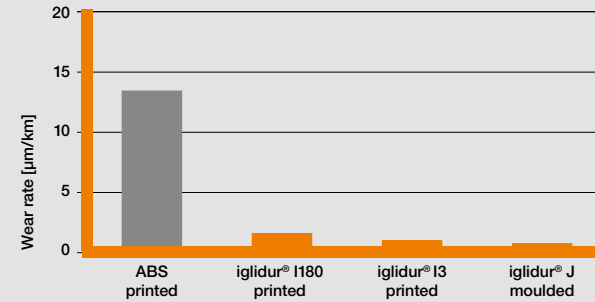
Wear, short stroke

p = 1 MPa, v = 0.1 m/s



Wear, linear

p = 0.11 MPa, v = 0.34 m/s, l = 370 mm



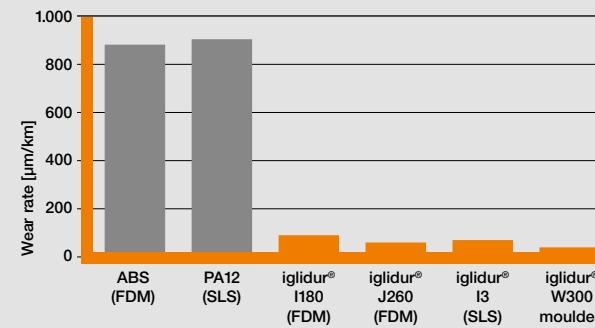
ABS printed



iglidur® I180 printed

Wear, rotating

p = 20 MPa, v = 0.01 m/s, V2A



ABS



PA12



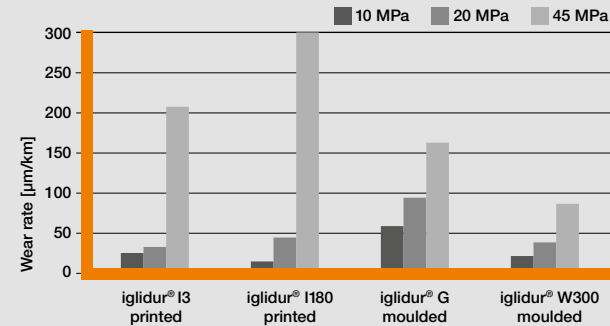
iglidur® I180



iglidur® I3

Wear, pivoting

Shaft: V2A v = 0.01 m/s; β = 60°



iglidur® I180



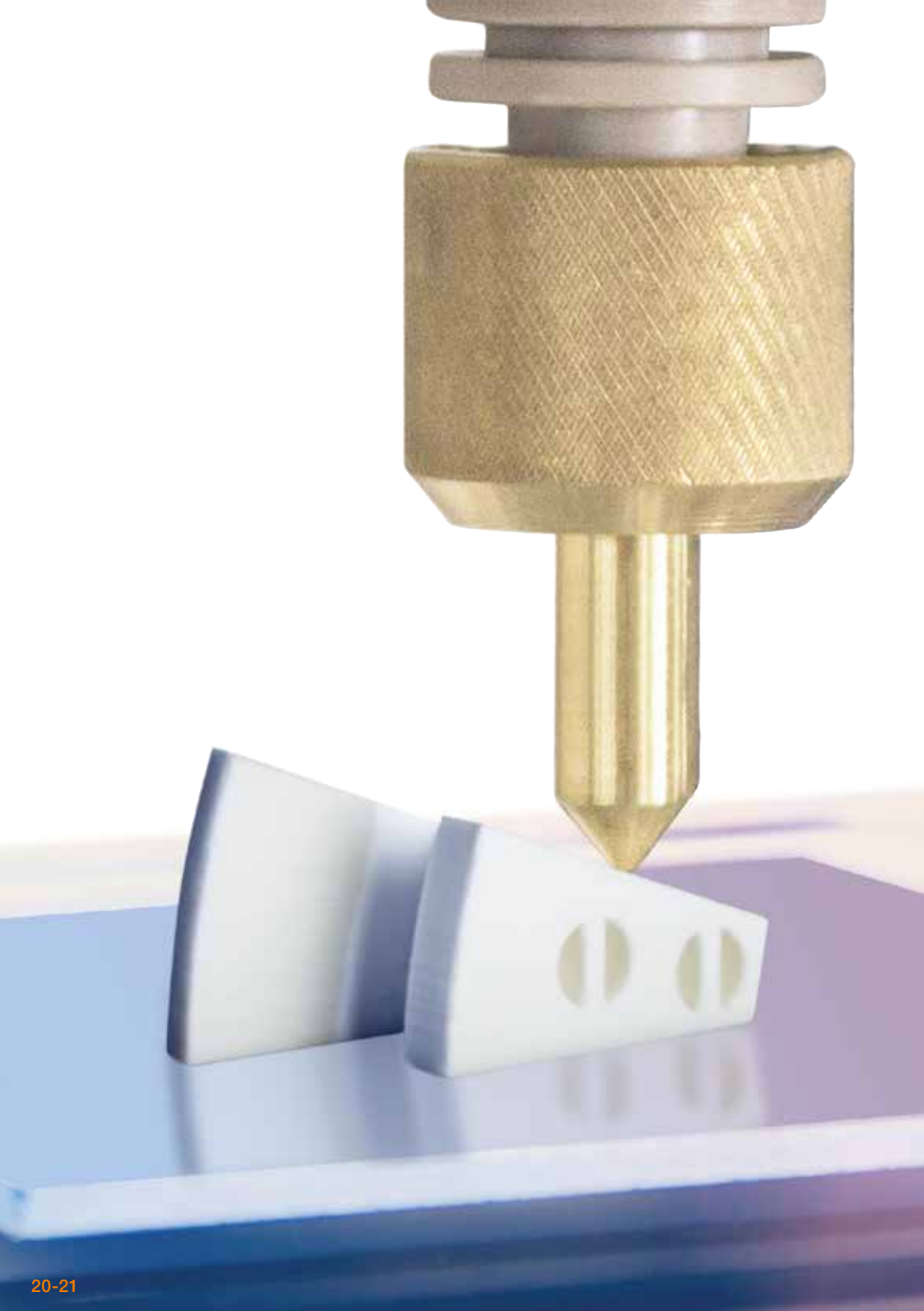
iglidur® I3



iglidur® G



iglidur® W300



3D printing service - for individual parts made from high-performance plastics

In two simple steps 3D-printed component - with instant price. We print your individual component, using lubrication-free, abrasion-resistant iglidur® high-performance plastics.

Upload your drawing in the STEP (STP) format, check the 360° view and select a filament. We ship your desired product - depending on the complexity - from 24 hours.

Tested strength when compared to machined and injection-moulded parts. 3D print materials from igus® are robust and composed of wear-resistant materials made of iglidur® high-performance plastics, which are especially suited for moving applications. They guarantee a long service life as well as a high abrasion resistance of custom-made parts.

Selection	Description	Thickness	Bearing strength	Delivery time	Unit price
1	igidur® 10-PL Colour yellow High wear resistance combined with maximum strength	10.2 mm	87 N/mm²	6-10 working days**	22.82 EUR
2	igidur® 11-88-2W Colour white Excellent wear and abrasion properties. High strength and elongation at break	10.2 mm	80 N/mm²	7-8 working days**	19.42 EUR
3	igidur® 11-88-0L-1W Colour black Excellent wear and abrasion properties, high strength and elongation at break	10.2 mm	80 N/mm²	7-8 working days**	19.12 EUR
4	igidur® 12-60-PP Colour yellow Improved chemical resistance and some resistance at higher application temperatures	10.2 mm	77 N/mm²	7-8 working days**	19.34 EUR
5	igidur® 11-78-PP Colour yellow Improved wear resistance (30% TPO-Process)	10.2 mm	75 N/mm²	7-8 working days**	16.40 EUR

Quantity: 1 Total price: 22.82 EUR (incl. shipping costs 0.00 EUR)

* For component sizes up to 50 mm, exact information from
** Complete components must be printed on the igus machines in Germany (Germany). Thereby, the delivery time is extended to 3-5 working days.

igus® 3D printing service:
easy, fast & transparent.

 www.igus.eu/3dprintservice



www.igus.eu/3d-print

Wear-resistant gears in 60 seconds using the new igus® gear configurator

With the new gear configurator from igus®, gears can now be configured online in just one minute and ordered immediately in the igus® web shop. In the igus® 3D printing service, the gears, consisting of iglidur® I6, are printed with the SLS method. The high-performance plastic specifically developed for gears is characterised by high wear resistance and, when tested, beats machined gears made of common materials such as POM and PBT. Making gears without special equipment is almost impossible due to the complex involute toothing. In order to facilitate the work of designers, igus® has now developed a simple and practical tool with the gear configurator. This allows each customer to configure his/her own gears even in special dimensions. In a few steps, the user only needs to enter the specifications of the required gear; such as the tooth module, number of teeth, width and inner diameter. This automatically displays a 3D model that can be exported as a STEP file. If the file is uploaded in the framework of the igus® 3D printing service (www.igus.eu/3dprintservice), the configured gear made of the new extremely durable SLS material iglidur® I6 for gears can be ordered immediately from igus®. With a mouse click, the user can order his/her wear-resistant gear with no minimum order quantity or request a quotation. In just three days the custom-made gear made from the wear-resistant material iglidur® I6 is ready for shipment.



Configured and ordered in just a few minutes! Gear from the new igus® gear configurator.



www.igus.eu/gear

Material iglidur® I6:

- Specially developed for use as a gear
- Longer service life than conventional gear materials
- Increased design flexibility, since no tools are required
- Production of gears by laser sintering from batch size 1



POM
321,000 cycles
High wear

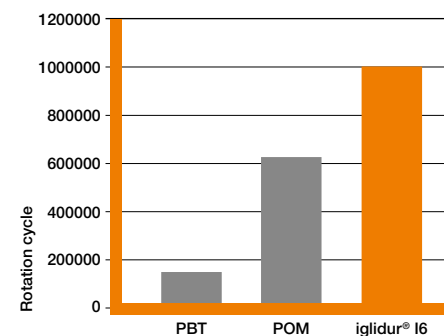


POM
621,000 cycles
Failed



igidur® I6
1 million cycles
Low wear

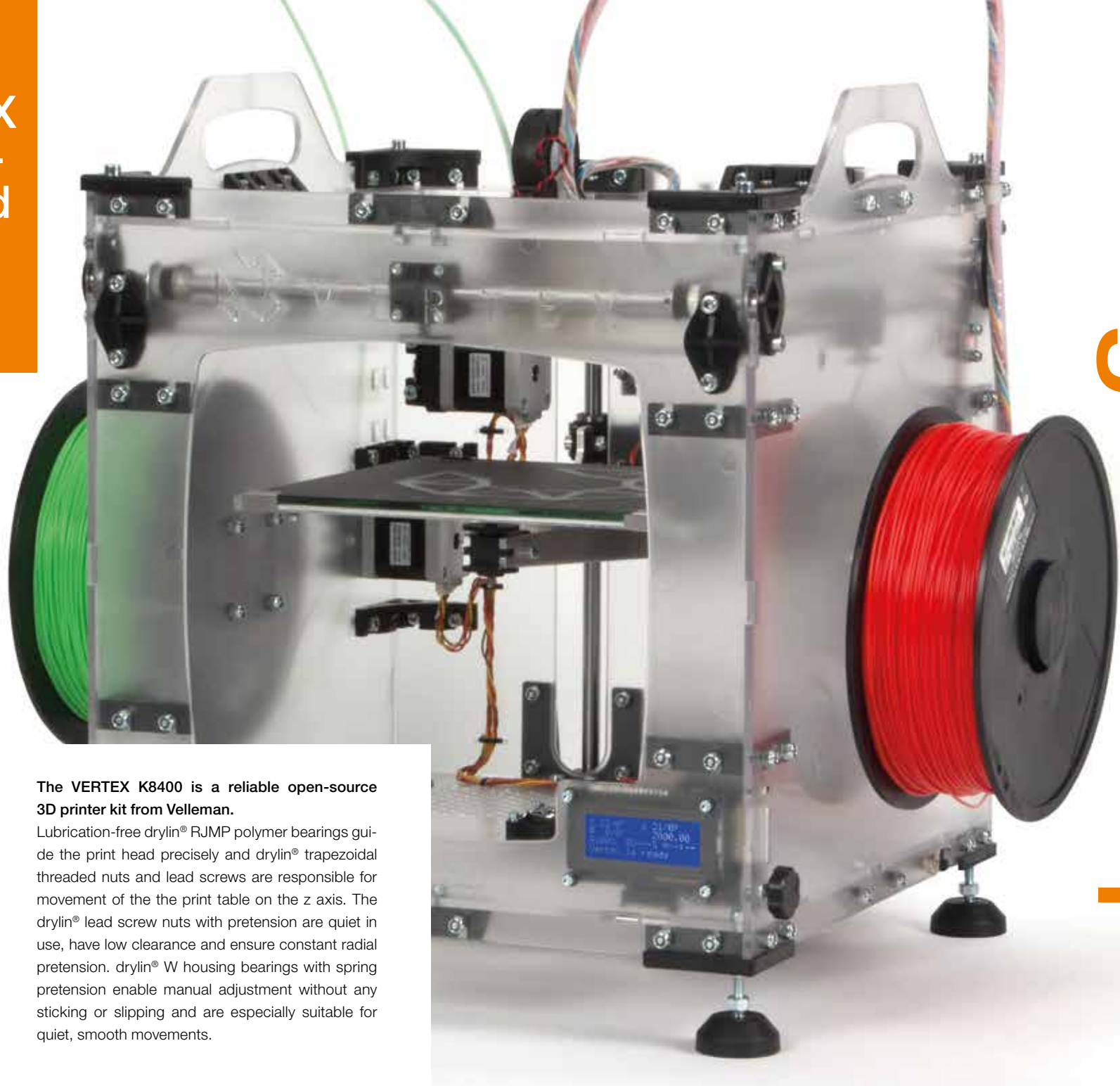
Service life of worm wheel in the test at 12 rpm; 4.9 Nm



Double the service life

In the test, iglidur® I6 showed itself to be considerably better than machined gears. Gears made of POM had total wear after 621,000 cycles, while machined PBT gears broke after 155,000 cycles, whereas gears made of iglidur® I6 continued to be functional after more than 1 million cycles.

drylin® in VERTEX
3D printer - light-
weight, quiet and
lubrication-free



The VERTEX K8400 is a reliable open-source 3D printer kit from Velleman.

Lubrication-free drylin® RJMP polymer bearings guide the print head precisely and drylin® trapezoidal threaded nuts and lead screws are responsible for movement of the print table on the z axis. The drylin® lead screw nuts with pretension are quiet in use, have low clearance and ensure constant radial pretension. drylin® W housing bearings with spring pretension enable manual adjustment without any sticking or slipping and are especially suitable for quiet, smooth movements.

www.igus.eu/3d-print

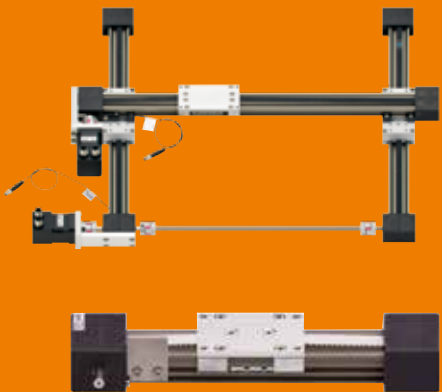


The house from the XXL 3D printer

Simply huge:
the mobile XXL 3D printer
on the inside.



With the second generation of the "Kamer-maker 2.0", Actual can print larger elements with high precision and greater speed. With his mobile XXL-size 3D printer, our customer from the Netherlands constructs entire buildings. This is not just environment-friendly, variable and practical, it also simplifies the logistics considerably: the elements are printed locally, put in place on site and then filled with concrete. The print head of the 3D printer is moved with a room linear robot from igus[®]. drylin[®] toothed belt units, lead screws/nut systems, igubal[®] pillow block bearings and igus[®] energy chains[®] are used.





"The remedy!"
Important
replacement
part from the
3D printer



new

old

A very interesting story took place a short time ago at igus®.

A small defective gear in one of our tractors meant the engine no longer started and that the tractor would have to be scrapped. The challenge was that the part to be replaced was damaged and it was therefore not possible to simply scan it and print a replacement part. An attempt therefore had to be made to draw the defective part. It was successful! The tractor is now working perfectly.



Lubrication-free, precise and light - igus® in 3D printers

A complete system for new ideas.

igus® offers you lubrication and maintenance-free components and ready-to-install system solutions - ideal for any installation space. **Plain bearings, linear guides, energy chains®** and suitable **cables** in many installation sizes and materials inspire creativity in design engineers. Energy chains® fabricated with cables and plugs or ready-to-install linear axes with motors make assembly easier and reduce the risk of malfunction.

Durable construction with lightweight components, quiet operation based on the "sliding instead of rolling" principle, resistance to contamination thanks to the omission of lubricants. igus® offers a wide variety of solutions - reliable in guiding and connecting the print head - with a flat design for maximum pressure volume.

Benefits of igus® products in 3D printers:

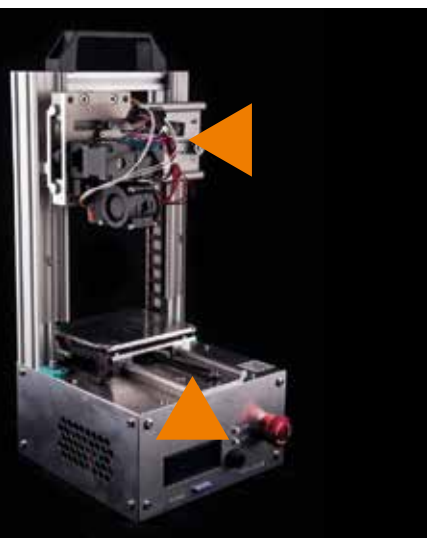
- Lubrication-free
- Silent operation and smooth sliding
- Resistance to dirt
- Long service life
- Corrosion-resistant
- A wide array of variants and material types
- Delivery from stock, from batch size 1 in as little as 24h

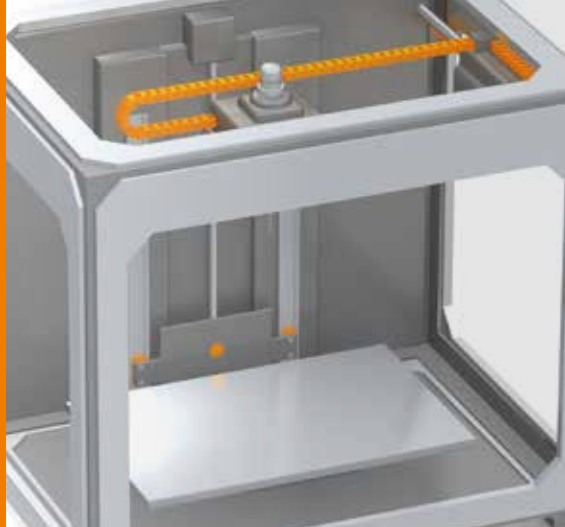
drylin® W profile guides are a cost-effective system. The design allows flexibility during build and installation thanks to the use of individual or double rails.



Extremely flexible and cable-friendly design: the triflex® R 3D e-chain®

www.igus.eu/3d-print



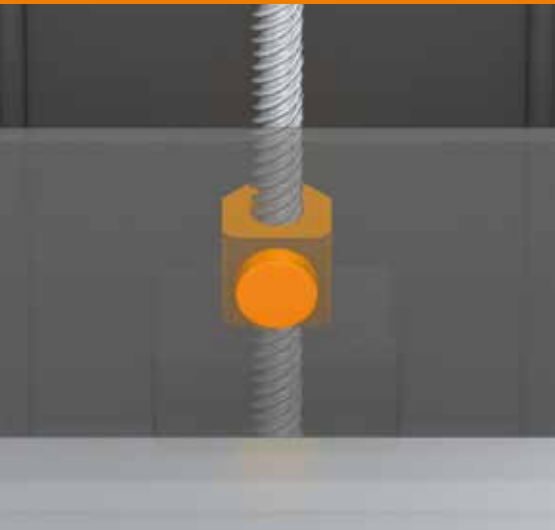


E2.1 micro e-chain®: cable guide for print head

- For smallest bend radii
- Lightweight
- Quiet operation



www.igus.eu/E2micro

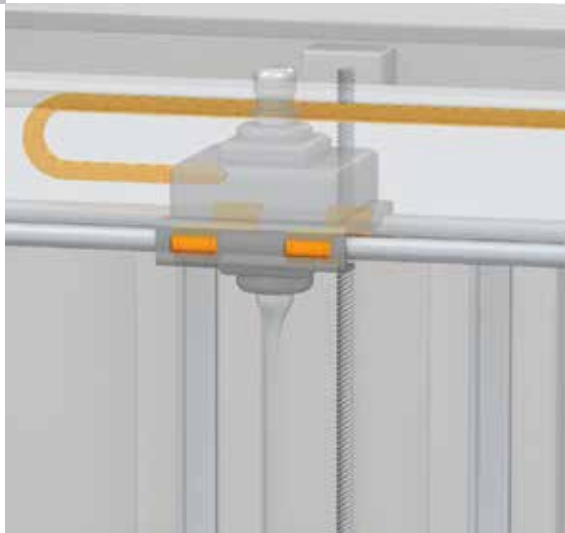


drylin® lead screw technology: print table lowering mechanism

- Quiet operation and low clearance
- Constant radial pre-loading
- New lead screw nuts made of iglidur® E7: silent and long-lasting



www.igus.eu/drylin



drylin® R in shaft guide: linear movement of the XY axis

- Very low coefficients of friction during dry operation
- Corrosion-free
- Same dimensions as standard ball bearings



www.igus.eu/drylinR

drylin® E7 in shaft guide: high acceleration rates and temperatures up to 80 °C

- Service life up to 8 times longer on steel and stainless steel shafts
- Precise and resistant
- For drylin® linear bearings and housing with ø 10-60 mm

 www.igus.eu/drylinR

drylin® W in SLS printer for best printing characteristics

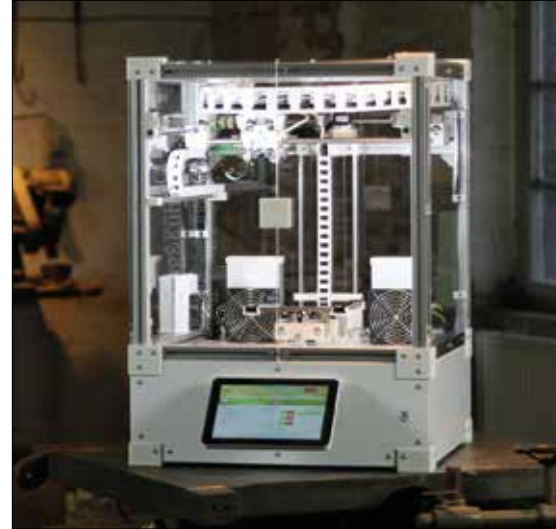
- Robust and dirt-resistant linear guide
- Lubrication and maintenance-free
- New: linear housing with spring pretension

 www.igus.eu/drylinW

drylin® RJ4JP open-source printer: quiet and precise

- For manual movement without "stick-slip" effect
- Quiet and smooth movements
- Low weight and easy assembly

 www.igus.eu/RJ4JP



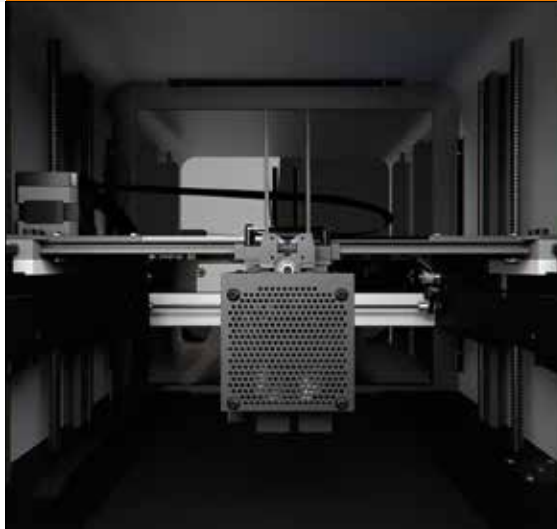
www.igus.eu/3d-print



drylin® N in print head: exact and uniform movement

- Extremely compact linear guide in four installation sizes
- For any installation space
- New: preload prism slide with constant spring pretension

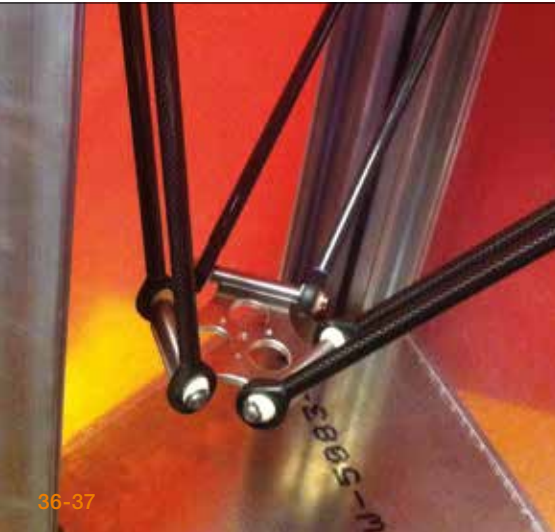
 www.igus.eu/drylinN



drylin® T in hobby printer: compact and cost-effective

- Classic low profile guide in four installation sizes (7-15 mm)
- Compact design, robust carriage
- With clearance adjustment if requested

 www.igus.eu/drylinT



igubal® in delta printer: light, flexible and robust

- Angle-compensation
- Precise guidance of the print head
- Available with inside and outside thread in many sizes

 www.igus.eu/KBRM



Tested ...



- Test: pivoting wear rate
- Load per bearing point: 25 N to 300 N
- Surface speed: 0.01 m/s



Extensive
test data-
base

Tested ...



- igus® extends the xiros® test stand in the industry's largest test laboratory for plastics in motion



Tested ...



- Test: service life of lead screw nuts
- Load: 25 N to 50 N
- Speed: up to 1 m/s



Tested ...



- Test: linear wear rate
- Load per bearing point: 10 N to 200 N
- Surface speed: 0.1m/s up to 0.3m/s



From more than 15,000 tests per year was created, what is probably the world's largest test database. This database gives us the ability to select always the right product for your specific application. Individual tests for your industry are also possible.

 www.igus.eu/test

www.igus.eu/3d-print

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The screenshot shows the igus.eu website interface. At the top, there is a navigation bar with links for 'Products', 'Industry Solutions', 'Service', and 'Contact'. A search bar is located in the top right corner. The main content area features a large orange banner for 'igus dry-tech' with the text '... now available in black ...' and 'Tribo-Partner for 3D printing now in black'. Below the banner, there is a section titled '3D print building: lubrication and maintenance free products for all 3D printers' and 'Bearing and energy chain solutions in 3D printers'. A photograph of a 3D printer is shown. The sidebar on the right includes a 'Your contact' section with a photo of Michael Wörning and a list of services: 'MyInjon', 'MyCatalog', 'No minimum order value', '24h - 24h Delivery-Consultation', 'Delivery from 24h', 'Free samples', and 'Is something not to your liking? / feedback'. At the bottom of the sidebar, there is a 'Newsletter Registration' link.

Always the right solution for 3D printing.

igus® is certified in accordance with ISO 9001:2008 and ISO/TS 16949:2009 in the field of energy supply systems, cables and harnessing, as well as plastic bearings.

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