

Micro giants in motion



We specialise in the manufacturing of high precision micro drive technology with the focus on accuracy and compact size.

We provide our customers with the very best quality, matching their needs throughout the development process, from consultation and design, all the way to the finished product.

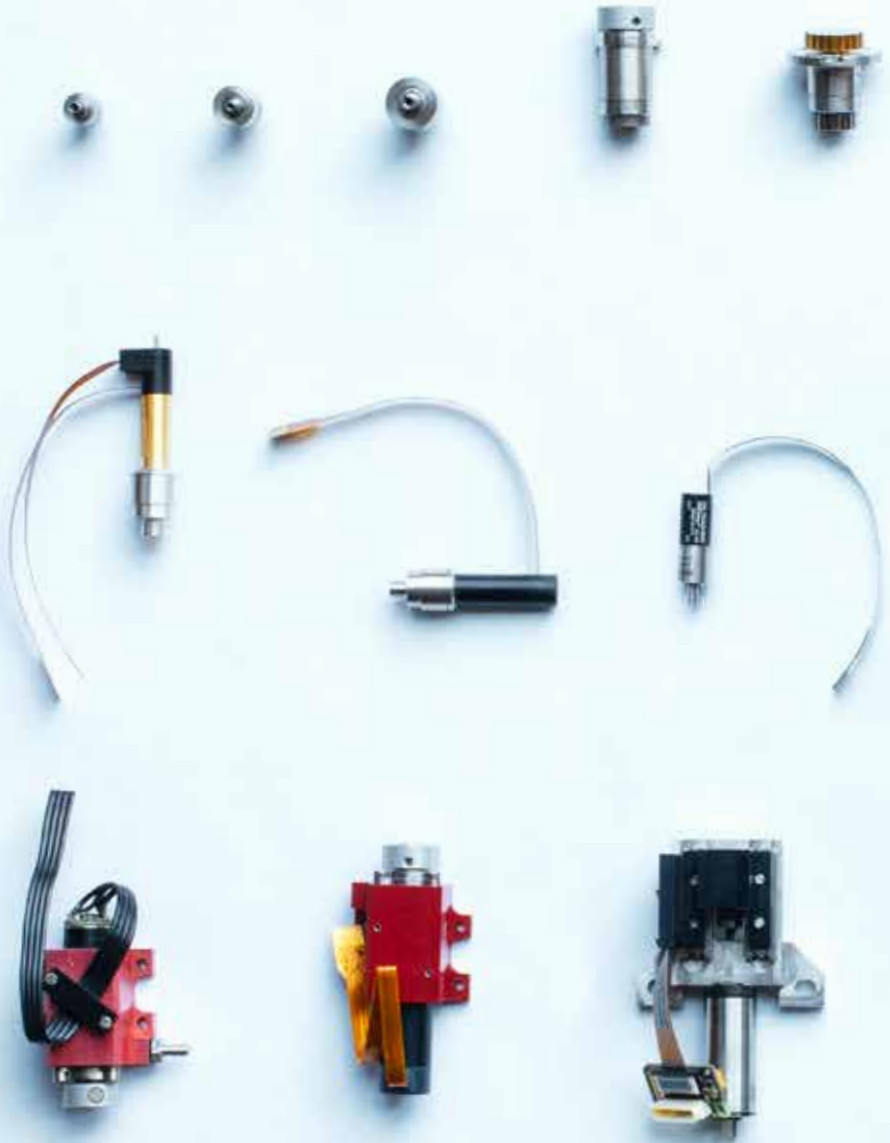


Enter »micromotion« in the App Store or Google Play Store and install the app on your smartphone or tablet. Now start the App and find out what's happening every time you find this symbol!

- 4 Our product lines
- 6 We are Micromotion
- 14 That's what sets us apart
- 15 This is what our micro gears can do for you
- 16 Our products in use
- 22 A plea for a closer look
- 24 Under the microscope
- 30 In four steps to a precise micro gear
- 32 Use under extreme conditions
- 38 Flowchart of a typical customer project

Our product lines

The smallest drives for the biggest tasks



MaalonDrive®

High accuracy micro positioning systems with zero backlash

CooGraDrive®

Highly durable and versatile rotary systems

Keevo Drive®

Linear drive systems with a stroke of up to 6mm



RasuunDrive®

World's smallest linear actuators
with strokes from 3mm

BryleeDrive®

Multi-axis systems from
Micromotion

Your application features special requirements?
We will be proud to match these as we specialise
in custom designed solutions.



WE

ARE

MICRO

MOTION

Ramona Marsch - production

Ramona is the mistress of heavy machinery at Micromotion. Whether it's grinding, lapping or the in-house electroplating system – as long as our gears go through our machinery, she treats them with her customary patience. Ramona makes sure our gears work smoothly thanks to our perfectly machined components. That's what makes her an indispensable part of the Micromotion team – and the 50-mile drive from her home every day doesn't put her off.



Reinhard Degen - management board

The heart of the company and our great gears guy – as the founder and CEO of Micromotion, Reinhard is the main point of contact for all the important issues, around the clock, 365 days a year. From inexplicable spontaneous electroplating events and the challenges of specific gear wheel geometries to particularly urgent customer requests – there's hardly an issue that doesn't eventually find its way to the CEO. Without Reinhard little or nothing would work here at all. He's what you could call Micromotion's very own in-house micro actuator.



Steffen Deumlich – construction and development

Nerd on board! This is fortunately the case, as what would the state of our engineering be without the obsessive attention to detail of our professionals in construction and development. This is the realm of Steffen, father of two and surprisingly well-versed in German history. His responsibility is to gather together the construction requests of both customers and production, anything from a simple tool to a client-specific interface with a multitude of our drive systems – the bulk of our output goes through his grey matter before seeing the light of day.

Masanao Kobayashi - management board

The eminence grise in the background, representing our parent company Harmonic Drive AG and the other half of Micromotion's management board. Calm and always reflective in any matters that matter, Masanao stands out as a successful mediator between both companies, always accompanied by his characteristic dry humour. He is the bridge over any in-house drive-technology troubled waters.





Sandra Pöhlmann - production

Having only recently successfully completed the application process for our production unit, Sandra has made quite an impression with her excellent knowledge of precision engineering, her clear-sighted approach and a very steady hand, which have ultimately established her credentials. And the way things usually turn out with new members of any team, there's also the feeling she has always been with us.



Armin Belle - sales

Armin is the first port of call for the most important thing at Micromotion – our customers. Experienced and motivated, always cheerful and well-informed, it seems as though his corner of the office is always just a little bit brighter than usual. The fact that he exudes this feel-good mood alongside his technical expertise is a major reason how effectively he interacts with our customers. Of course, this doesn't prevent him from making precise analyses and a targeted commitment to a perfect match between the benefits of our drive systems and our customers' application requirements. He's an ever-present new business engine – exclusively at Micromotion.



Verena Göppner-Schneider - production

Our gear drives are developed in a clean room under a microscope. This requires a particular intuition, maximum concentration and a keen eye on the part of our production staff. Verena achieves all this and more – she manages the team through the uncertainties of deadlines to be met, changes requested by construction at the last moment and unavoidable reports to the next authority level upwards. Fortunately, this always works out well with a good dose of humour and lots of patience – for all concerned.



Luisa von Goertzke - marketing

As the only staff member with a background in economics, Luisa is something of a rarity in Micromotion's engineering-dominated world. Of course, this provides a healthy balance in general terms but is especially useful for her actual job within marketing. From basic strategy through to a wacky promotional idea for Christmas – doing business without advertising is like waving to someone in the dark. In keeping with this principle, she provides more light in the world of micro drive systems.

That's what sets us apart

Our company philosophy – outstanding together

Excellence is our standard

Micromotion stands for technological innovation and the highest level of quality awareness. It is our philosophy to always be a step ahead of the current state of the art. We take what is technically feasible and transform it into intelligent innovation. On many occasions our excellence has been honoured, this is the standard against which we measure ourselves daily. You can place high demands on a product from Micromotion.

It's all about our customers

Our customers' requirements form the basis of our business activity. We develop trusting cooperation through open communication with our customers. You are our priority at all times.

Better together

Micromotion is a young company and teamwork is highly important for us. Our approach is solution and result orientated. Together, we take on challenges creatively and passionately. It's not enough for us to be good – together we are always better!

Commitment to the highest standards and quality means satisfied customers

Customised solutions

Whether in industry or research, micro and nanotechnology are now used in numerous sectors. Micromotion specialises in customised solutions based on our customers' needs. Together with you, we analyse requirements and environmental conditions, develop process specific solutions and operationally reliable systems on the highest technical level. During this process, we support you with our extensive experience in engineering and creative application knowledge – combined with 100 percent focus on your requirements.

You tell us what, we'll tell you how. With batch sizes starting from one.

This is what our micro gears can do for you

- 
- > withstand with extreme temperatures from -183°C up to 200°C
 - > minimal masses
 - > minimal sizes
 - > biocompatibility
 - > resistant to corrosion
 - > perfect fit with your application
 - > easy to control, regardless of the environmental conditions
 - > open and closed-loop operation
 - > fewer interfaces combined with maximum space optimisation
 - > our expertise facilitates interfacing and makes handling and assembly of the microdrive easier
 - > higher degrees of integration
 - > small quantities, prototypes and small series
 - > maximum dynamics
 - > zero backlash



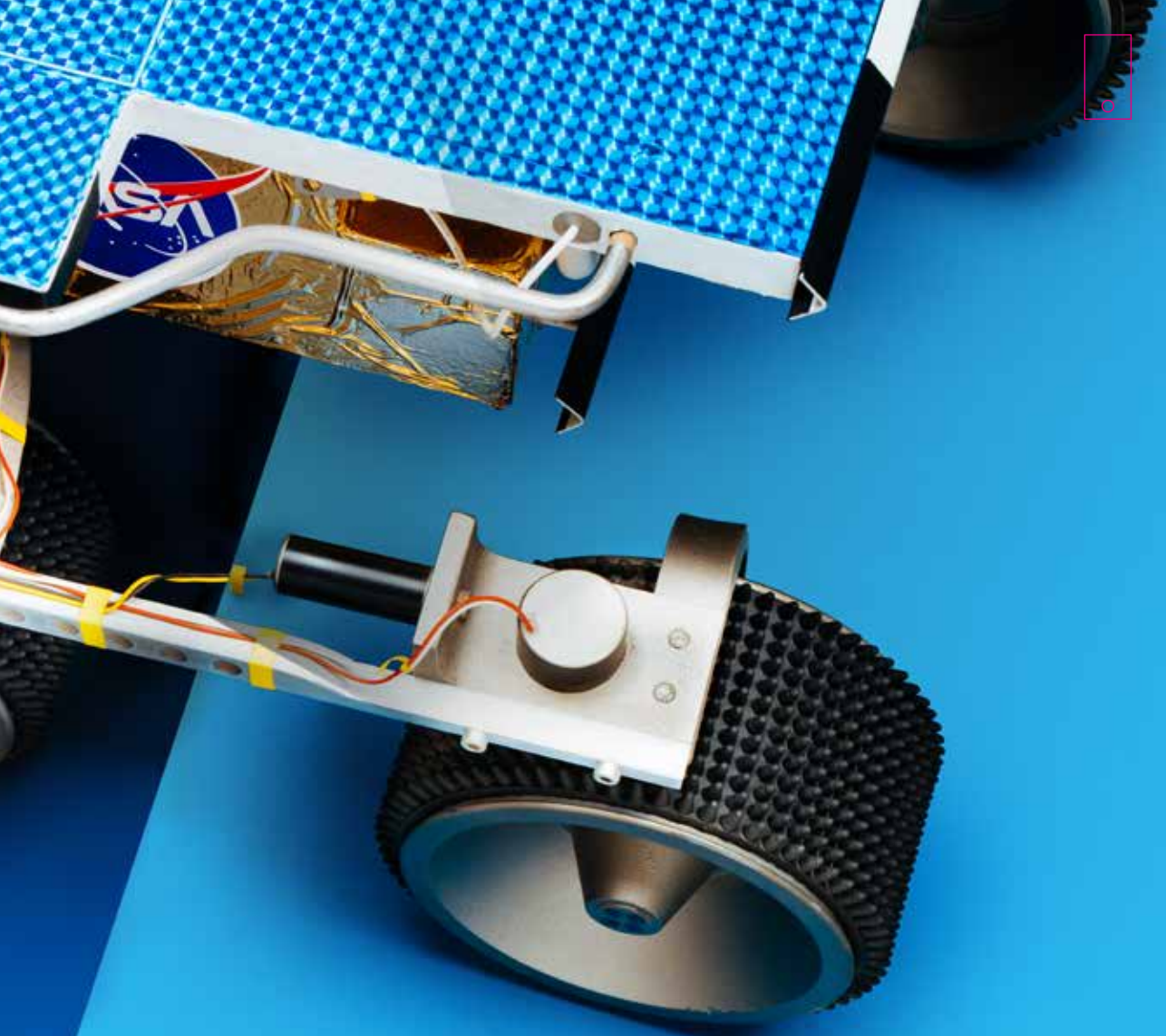
OUR

PRODUCTS

IN

USE





Space travel

Vacuum environments, such as those found in space, pose a difficult challenge when developing drive technology. Applications including satellites, rovers and those with extreme temperature fluctuations and pressures as low as 10-12 bar, place extraordinary demands on system components. To use precise positioning actuator technology in these demanding environments requires specific tribological coatings, special systems materials, as well as non-outgassing gears.


Micro drive technology is designed to overcome these problems. It can be integrated in the smallest of vacuum chambers, which eliminates the need for complex sealing systems and allows a more precise, higher resolution, positioning behaviour to be achieved in the sub-micrometre range. Typical applications involve the positioning and alignment of samples in an electron beam with nanometre precision or the precise adjustment of X-ray monochromator mirrors.

Medical technology

Reliability, long service life, biocompatible materials and minimal installation space, these are the central challenges engineers face when designing micro-drive components for medical technology. In ultrasound devices for sonography examinations, for example, the ultrasound actuator must be swivelled precisely and in a highly dynamic manner by means of micro positioning systems. From the angular locations, a 3D image data is calculated in real time. The more precise the angular position, the more exact the imaging technique and therefore the diagnosis.

The use of miniaturised actuator solutions from Micromotion ensures optimum application orientation. When looking for the right components for medical technology applications, the critical features to look out for include microscopic dimensions, high performance materials such as special titanium alloys and the ability to sterilise the equipment.





Semiconductor manufacturing

Miniaturised actuator systems are ideally suited for typical pick and place applications found in the semiconductor industry, where components such as miniaturised rotary actuators play a critical role. These actuators align extremely small chips with maximum angular accuracy in just a few milliseconds, before they are placed on a substrate. Here the Micromotion actuators offer the best balance of low weight and high accuracy. By reducing the weight, the basic axes can be reliably controlled with significantly

faster acceleration. They can also be actuated with extreme angular accelerations thanks to minimal moments of inertia. It is these characteristics that offer a simple, well controlled and stable operating behaviour for trouble free continuous operation and a dramatic reduction in cycle times. As a result, the entire application benefits from improved productivity.

Optics & lasers



Optical systems often present developers with problems that can be perfectly solved with precision micro actuators from Micromotion. In a typical application, micro drive technology can be used to focus lenses or mirrors. Here, precision and space are critical factors. The actuators must not outgas and must be suitable for integration in the typically complex beam paths.

In addition to compactness, maximum dynamics and high precision performance, our products also feature a hollow shaft that runs through the micro gearbox to guide the beam path to the central rotary axis of the drive. The hollow shaft allows our customers to simplify the design and make the application even smaller.



Biotechnology

Applications in extreme environments invariably pose the greatest challenges and place the biggest demand on materials and integrated system elements. In this sector, Micromotion products excel, ensuring that the system continues to run under demanding environmental conditions with uncompromising reliability and safety.

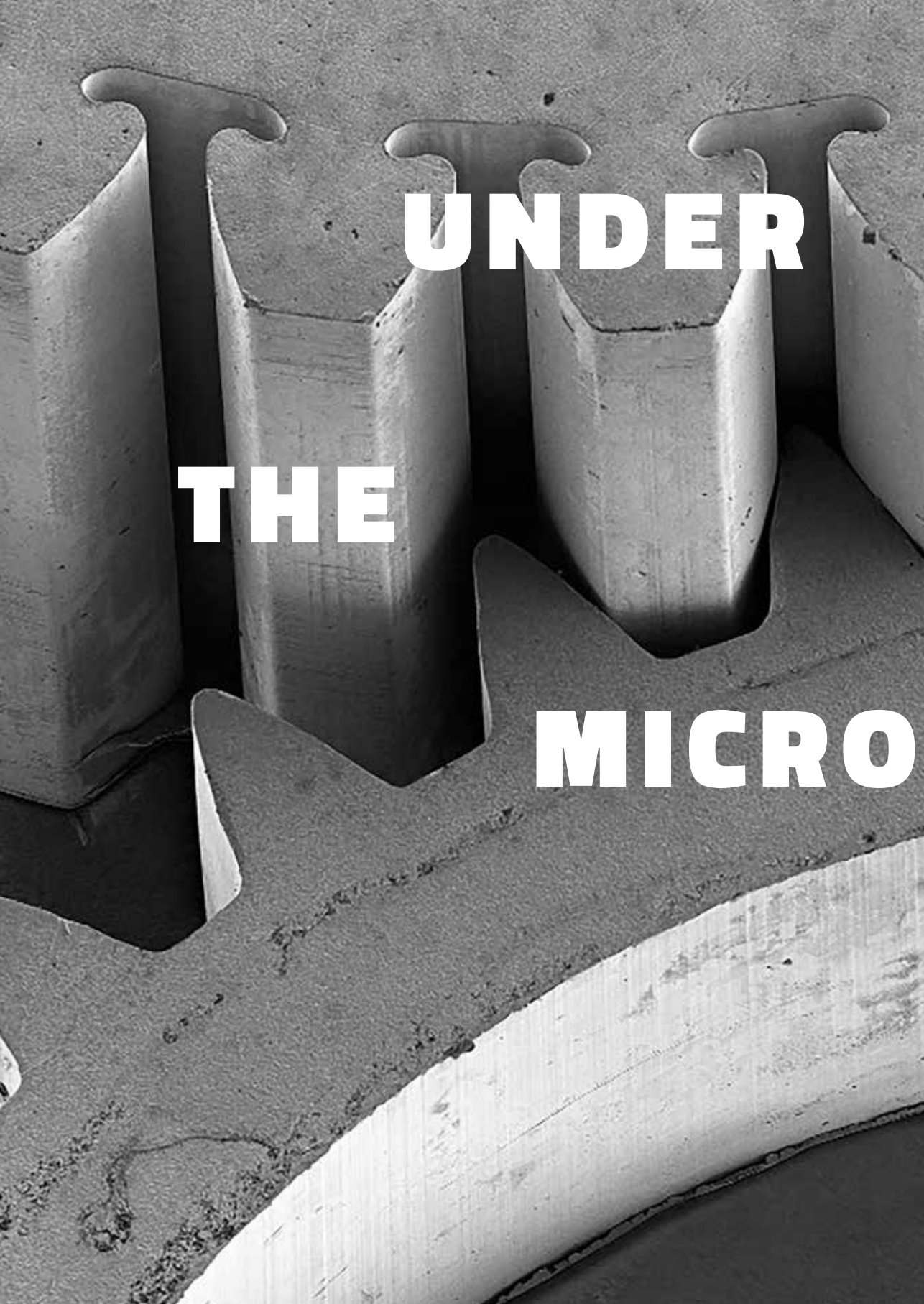
For example, in the field of biotechnology, hermetically sealed micro drive systems are needed, typically for sample manipulation, in an environment that poses a biological hazard. Contamination of the test environment by the actuators must be reliably excluded. In this environment, ensuring that equipment is sterile as well as resistant to corrosion and aggressive chemicals is vital, a challenge that our micro gearboxes master with ease.

A plea for a closer look

Since our founding in 2001, we have been working to continuously improve our high-precision microdrive systems. Precision was and is central to the work of Micromotion. But what does the term precision actually mean? Precision means the smallest possible deviation from an ideal value. Absolute precision results at maximum intolerance or zero deviation – a value that can never be fully achieved in practice. For products used in high-precision applications, this value is approached not only through the use and implementation of high-quality materials and production techniques, but also through precise measurement technology. This means you really have to take a very close look.

People who took a very close look were the astronomers of Julius Caesar who in 46 BC introduced the Julian calendar year and, in so doing, replaced the chaotic time-keeping methods that had prevailed up to that point: By observing the celestial bodies, it was determined that the length of one year was 365.25 days. This was achieved by using the available technical means and one was convinced of the precision of the method. Only generations later it became apparent that the calculations had not been sufficiently precise. Every 128 years, the distance of the Julian calendar increased by one day from the astronomical reality. Today, it is known that the Roman scientists miscalculated the duration of one year by eleven minutes. With the available technical means, fluctuations of the Earth's rotation simply couldn't be detected or even measured correctly. Even today, the effects of this lacking precision is anchored in our cultures. Orthodox Christians who adhere to the Julian calendar celebrate Christmas almost two weeks later than the rest of the Christian world.

Engineers at NASA, on the other hand, simply did not look close enough when in 1998 they fed the navigation system of the Mars Climate Orbiter with thrust control data. The manufacturer of the probe provided some of the data in imperial units - contrary to the instructions of NASA, which almost invariably uses the metric system. The engineers entered the data into the navigation system of the probe without converting it, which meant that all thrust controls were set too high by a factor of 4.45. When the Mars Climate Orbiter reached Mars on 15 September 1999, they wanted to fine-adjust the ignition of the engine when the probe entered the orbit. Instead of reaching a stable orbit at an altitude of 110 kilometres, the manoeuvre brought the probe down to 57 kilometres. At this altitude, the Martian atmosphere is so dense that a probe either burns up or bounces off like a stone. What exactly happened could never be determined, since the probe disappeared from the monitoring screens without a trace after the ignition of the engine. So what's the conclusion of these examples? Precision is an iterative process; in this sense, it should always be doubted and reviewed continuously. This willingness to doubt, review and ultimately improve is not only what distinguishes our engineers, it is practised by every member of the Micromotion team. Although generosity and forbearance can indeed be ascribed to us, when it comes to precision, we take a very close look.



UNDER

THE

MICRO



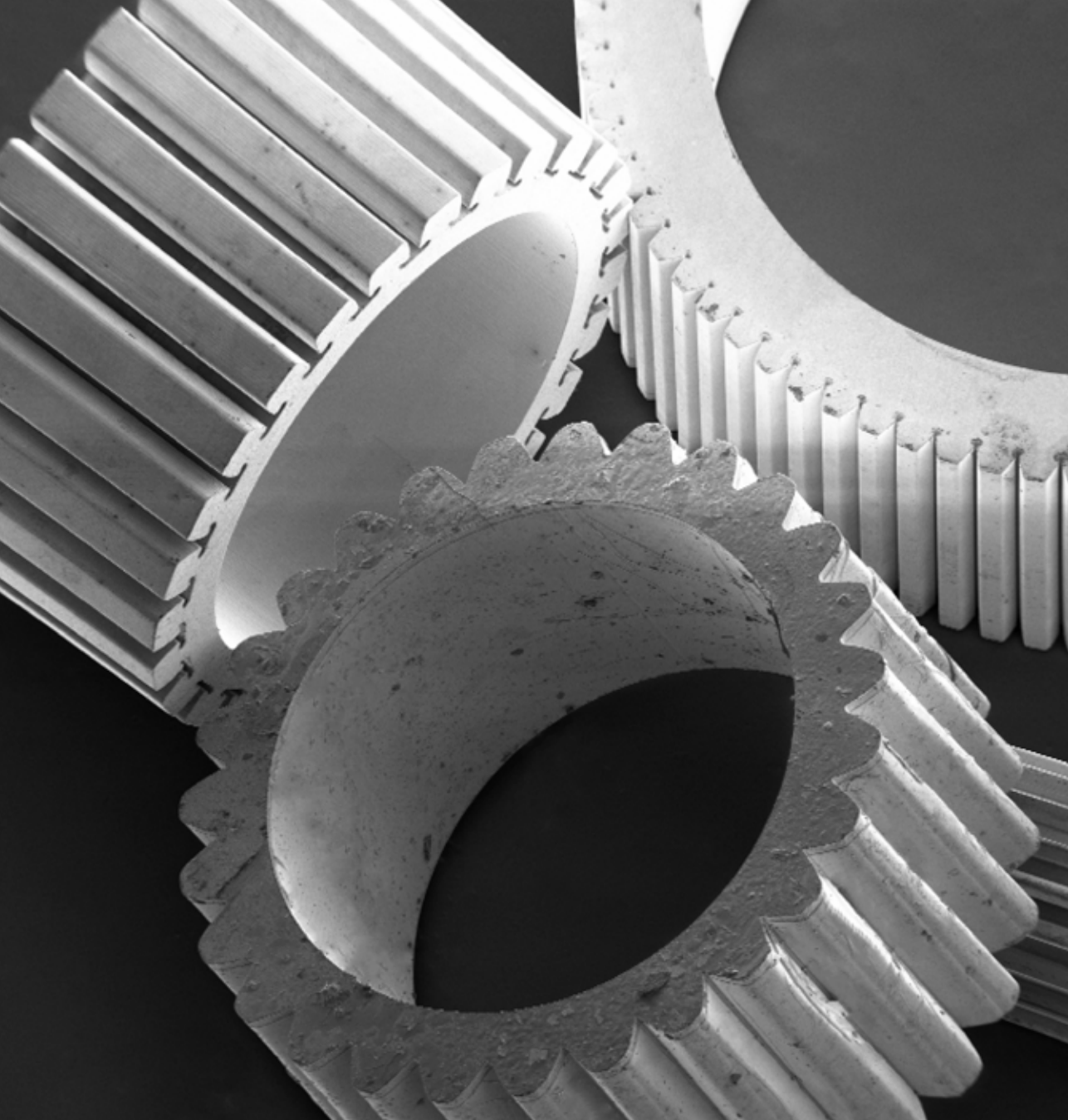
200 Micrometer

SCOPE

WORLDWIDE UNIQUE

The zero backlash gears, the heart of a number of our products, function according to the globally unique principle of our parent company, Harmonic Drive AG.

Harmonic Drive® gears consist of four elements; the Wave Generator, the Flexspline, the Circular Spline and the Dynamic Spline. Here, the Wave Generator consists of a sun gear wheel – typically mounted on the motor shaft – and two or more elastically deformable planetary gear wheels.



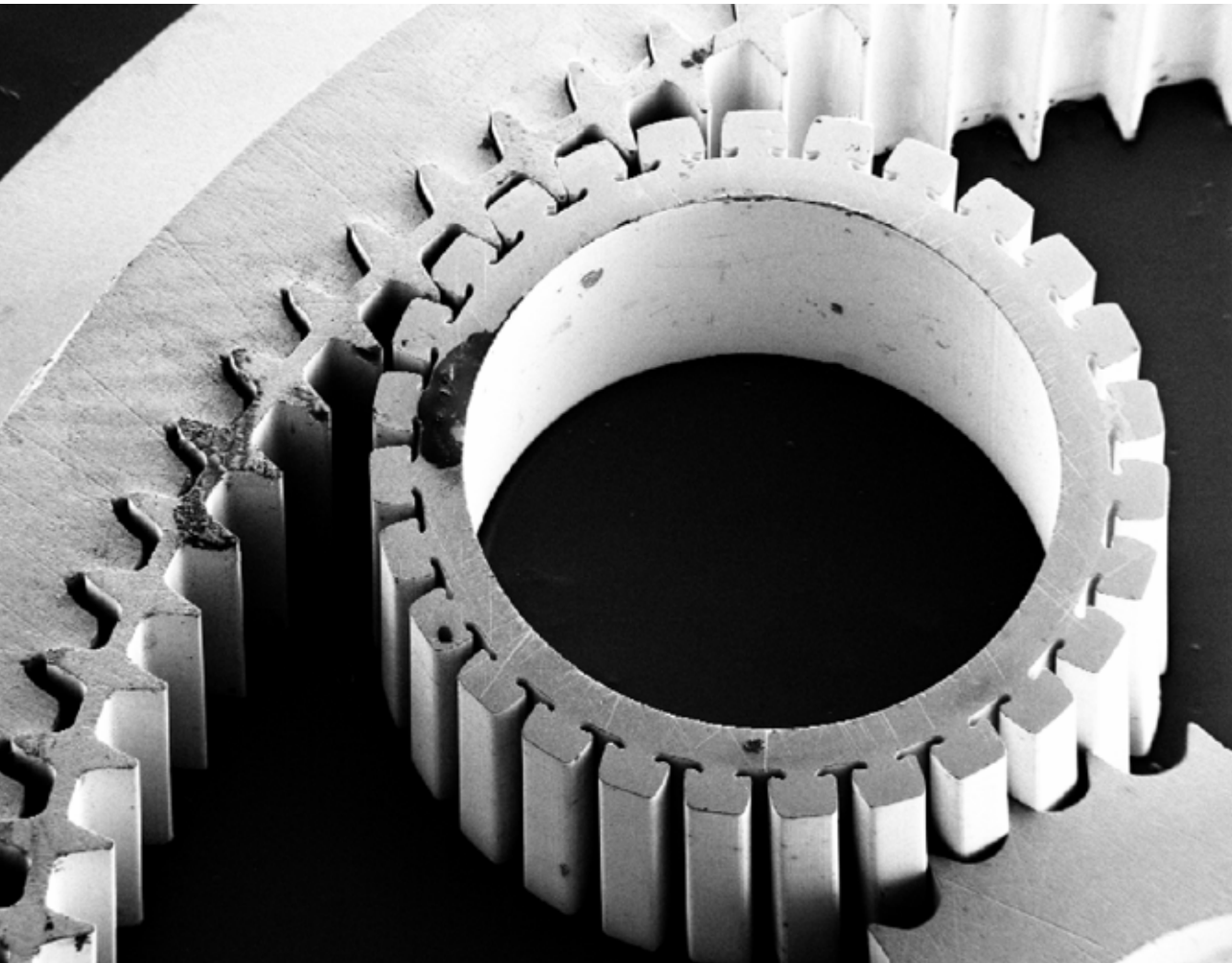
The sun gear-wheel of the Wave Generator serves as the drive element. By means of the planetary gear wheels, the Wave Generator deforms the Flexspline, which engages with the Circular Spline and the Dynamic Spline. As the sun gear-wheel turns, the planetary gear-wheels of the Wave Generator travel — the major elliptical axis shifts and, thus, and so does the position of the tooth engagement.

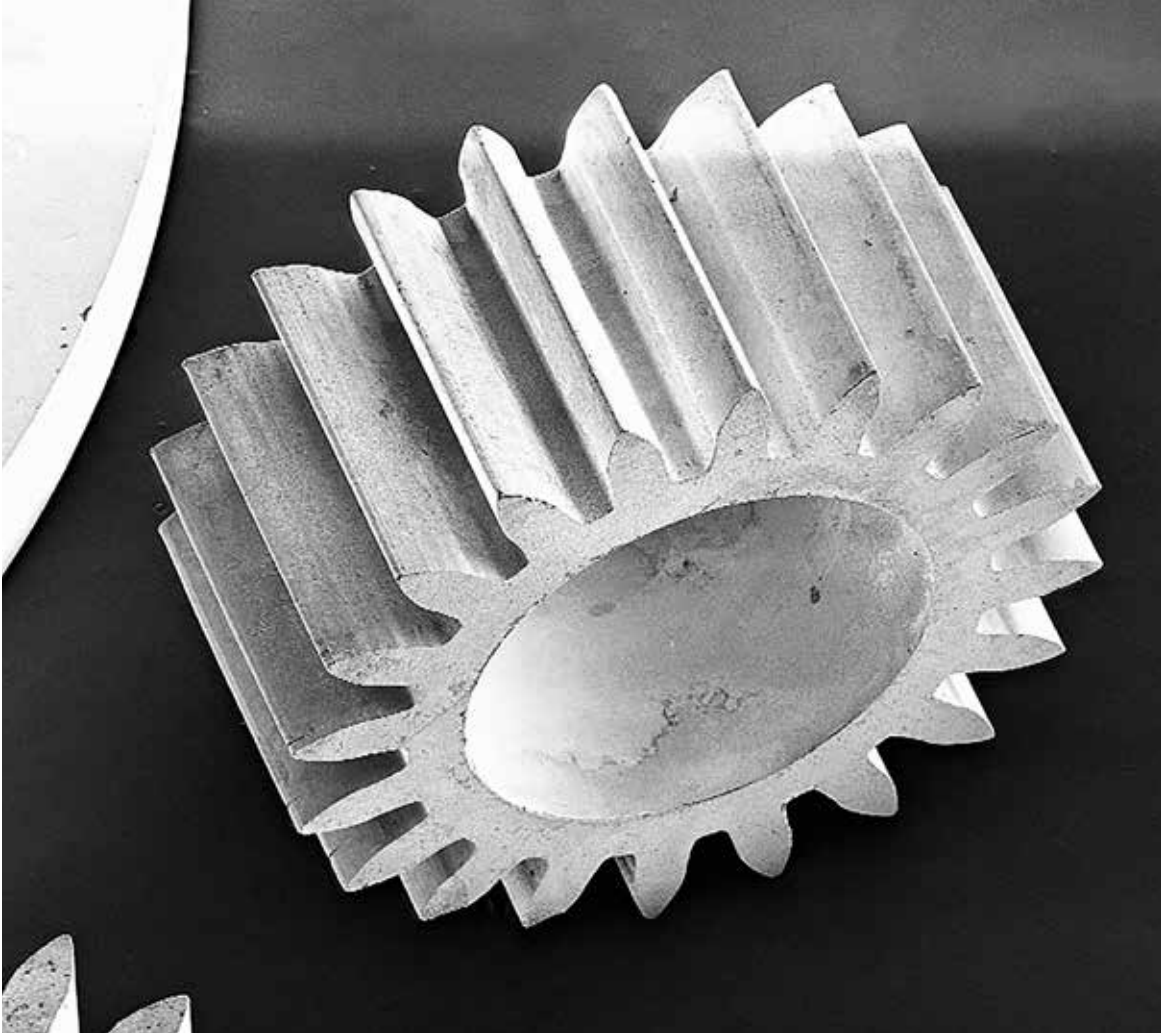


The Flexspline has two fewer teeth than the Circular Spline and, thus, one rotation of the Wave Generator, causes a shift of two teeth between the Flexspline and the Circular Spline. Fixing the Circular Spline in place causes the Flexspline to move in the opposite direction of the sun gear-wheel. The Dynamic Spline rotates in the same direction and with the same speed as the Flexspline is used as the output drive element.



With this system, a large number of gear ratio variations can be produced, without needing to make changes with respect to the installation space. It is also possible to flexibly adapt the very high speeds to a wide range of requirements without causing any problems. An exceptionally low moment of inertia allows for high dynamic accelerations and positioning movements successfully completes the package.





We didn't reinvent the wheel – but we did significantly optimise and intelligently rearrange it.

In four steps to a precise micro gear

The direct LIG process:

The manufacturing process for our components is a highly complex sequence of operations that uses a variation of the so-called LIGA process. Micromotion employs deep X-ray lithography, followed by alloy electroplating, to produce high-strength micro components. Lithographic processes enable the creation of structures with maximum precision with dimensions in the micrometre range. This technology allows a high degree of control over the process. This process takes place in four steps.

1 – EXPOSURE

The gear structures are located on the absorber layer of a mask and are very precisely transferred, by shadow projection, into a photoresist. They have heights from one millimetre and deviations of less than one micrometre using high-energy, shortwave and absolutely parallel synchrotron radiation.

2 – DEVELOPMENT

Through the subsequent development process, three dimensional negatives are produced.

3 – GALVANIC MOULDING

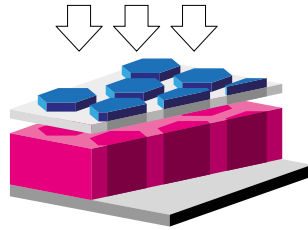
The moulds for the gear structures are then galvanically moulded with nickel/iron electrolyte.

4 – COMPONENTS

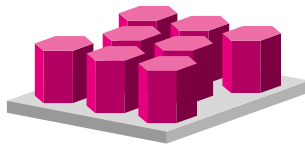
Following galvanic moulding of the gears, the tooth width of the micro gears is created through machining. The gears consist of a high strength metal, are corrosion resistant, can be autoclaved and used in a very wide temperature range as well as in an ultra-high vacuum.

*Extreme operating conditions require special manufacturing processes.
Here, we set new standards.*

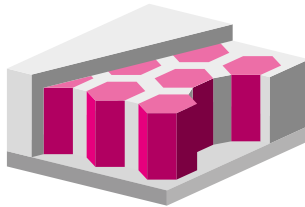
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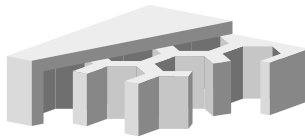
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3



4



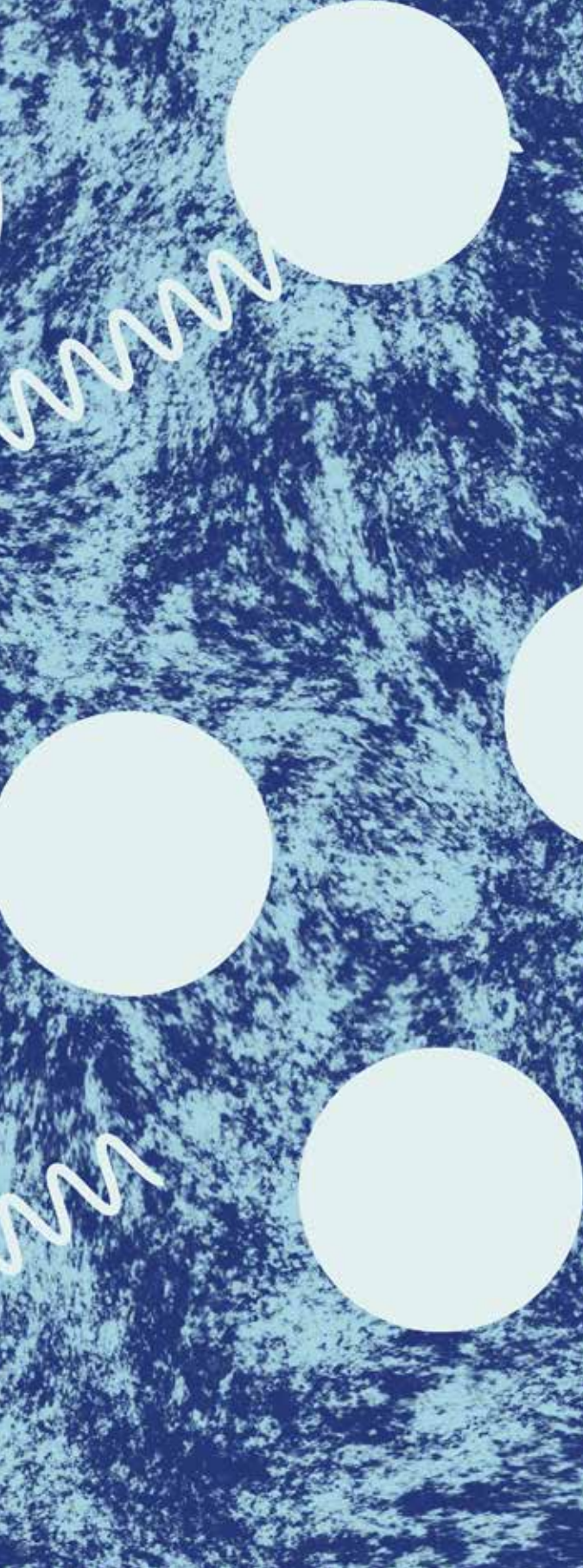


USE

UNDER

EXTREME

CONDITIONS



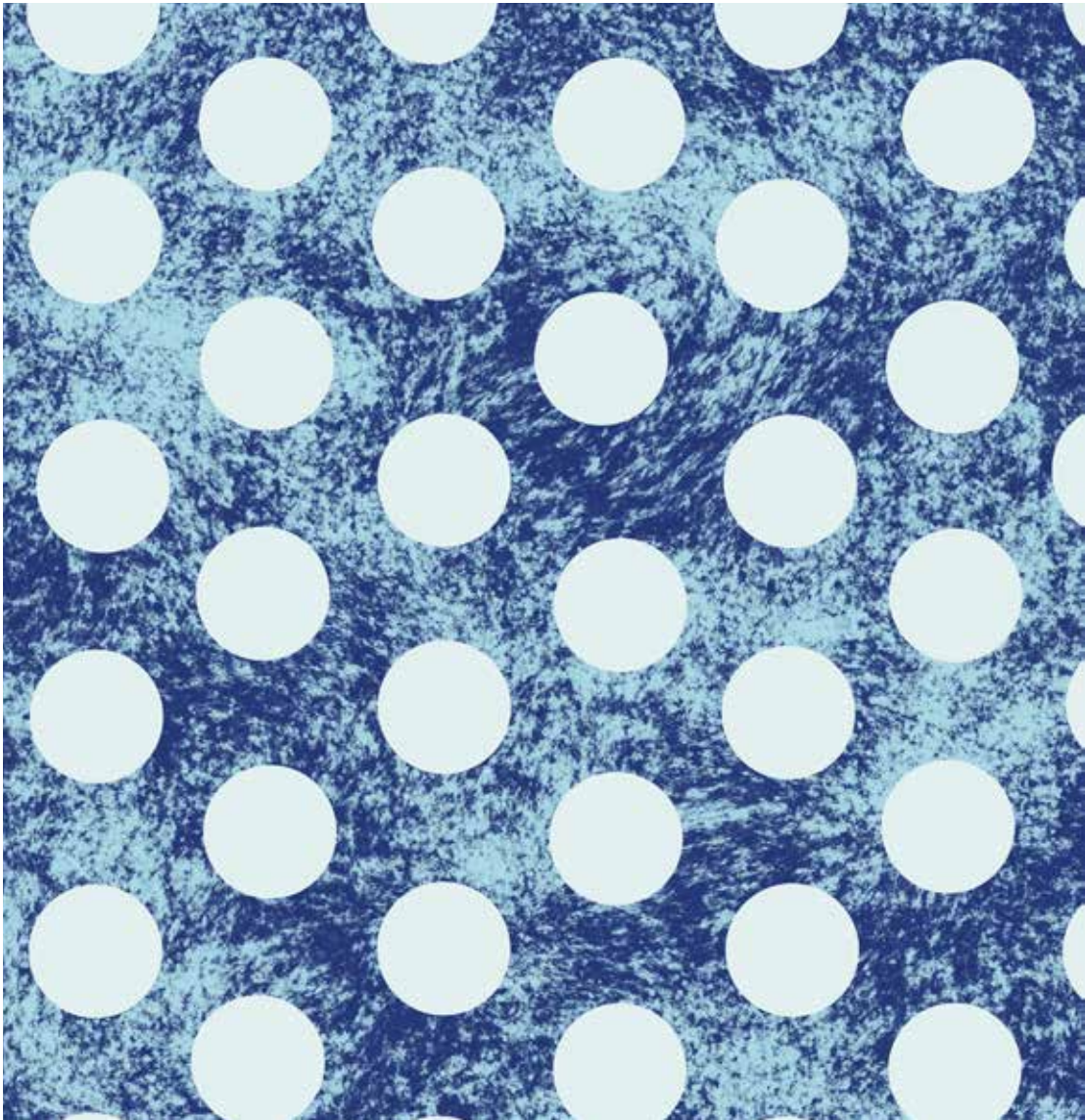
Radiation

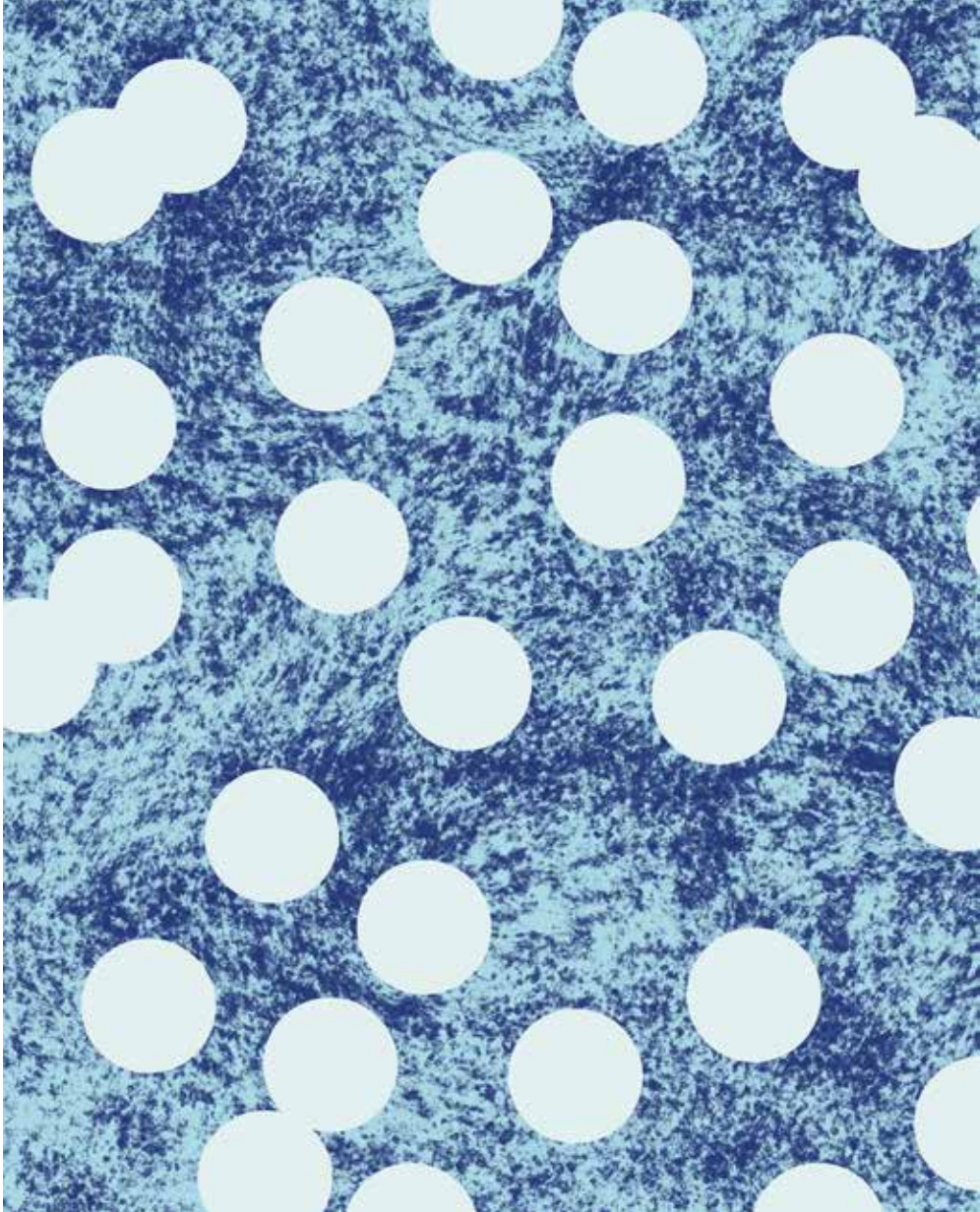
Micromotion microdrive systems work reliably and fail-safe in a variety of extreme operating environments. Even conditions involving high levels of energy and electromagnetic radiation, as can be found in the operating environments of satellites or space probes, have no performance-reducing effects on our microdrives. To ensure this, all drive components are made of corrosion-resistant, high-quality metals. For the adhesive bonds, radiation-resistant, highly cross-linked adhesives are used; as for lubricants, we can resort to dry lubricants. Instead of fats, we use coatings with molybdenum disulphide and tungsten carbide. Thanks to robust, reliable stepper motor technology, there is often no need for the highly sensitive semiconductor electronics used for motor control or in encoders. If they are absolutely necessary, the sensitive electronics can be shielded by enclosures made of aluminium, tantalum or even bored glass.

Low temperatures

Low-temperature applications such as cryo-research for cold matter studies (superconductivity) or space applications pose particular challenges to this technology. The miniaturisation of drive technology offers two very important advantages in this respect: On the one hand, microdrives can be integrated into minute probe chambers, on the other hand, they generate very little waste heat and only minimally heat up the probe chamber. In order to be able to reliably operate microdrives in these temperatures, highly adapted

materials are required. These not only have to be matched to one another according to their linear expansion behaviour, their mechanical properties must not change and they must not become brittle. The viscosity of conventional lubricants increases dramatically at extremely low temperatures, which can potentially mean that the motor can no longer make up for the power dissipation. To overcome this problem, Micromotion uses highly adapted coatings to ensure optimum performance of the drives.

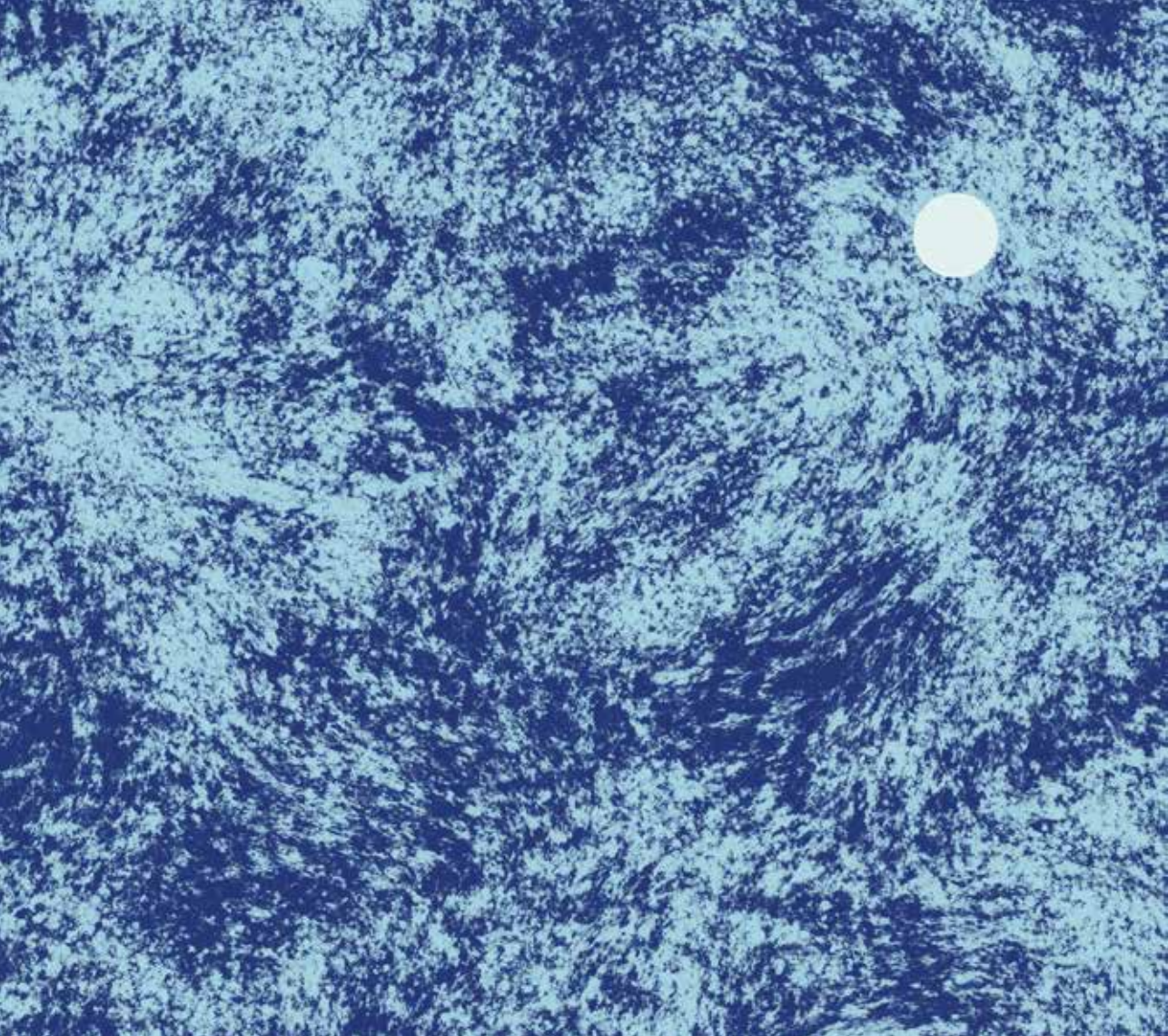




High temperatures

Thanks to the specialised technology, the drives of Micromotion GmbH can be used in temperatures up to +200°C. High-quality, corrosion-resistant materials provide for perfectly tuned linear expansion and guarantee maximum stability of the mechanical features, e.g. strength,

even in extremely high temperatures. This is why temperature-hardening adhesives whose strength increases with increasing temperatures are used for bonding.



Vacuum

Vacuum applications also have a number of special requirements for drive systems. Meeting these requirements is one of our core competences at Micromotion. For example, we pay a great deal of attention to the degassing behaviour of the materials used, in particular lubricants. The metal gears made of corrosion-resistant materials can be applied with vacuum-suitable lubricants, which have a particularly low vapour pressure. Under extreme ultra-high vacuum conditions, dry lubricants

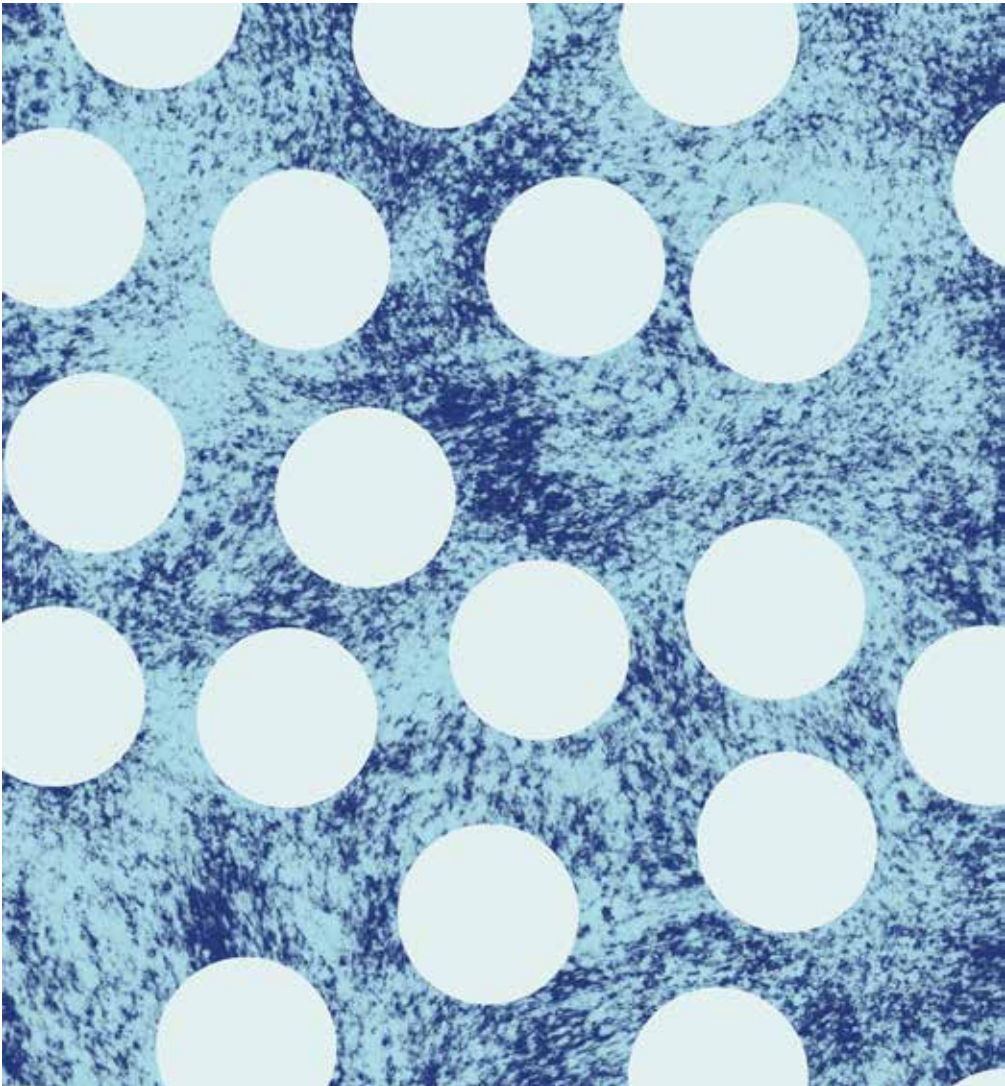
can be used even for the drive unit itself and the ball bearings. The design of the drive, which is made entirely of metallic components, ensures a good thermal coupling of the drive, since no heat transfer by convection takes place in a vacuum. Thanks to the suitability of our positioning drives for operation in vacuums, costly vacuum chambers are a thing of the past. Precision of the positioning movement is significantly improved.

Dynamics



The miniaturisation of drive systems has a number of positive effects on their operational capability, especially in terms of dynamics. The mass reduces disproportionately to the external dimensions, increasing the attainable acceleration progressively. In our gear units, this effect is apparent in the extremely small mass moments of inertia of up to $1 \cdot 10^{-5} \text{ gcm}^2$. Due to the high reduction ratios in just one stage, the microdrive serves as a kind of intersection between the motor and the load moment of inertia of the application. The

mass moment of inertia to be accelerated by the motor is reduced to a minimum and thus allows for a particularly dynamic control behaviour. As a result, extremely dynamic positioning axes with angular accelerations of up to $550,000 \text{ rad/s}^2$ can be integrated in e.g. production machines. This corresponds to a movement from 0 to 100,000 revolutions per minute in just 0.025 seconds on the motor side with a repeat accuracy in the angular second range.



Flowchart of a typical customer project

STEP 1 **PROJECT START** approx. 1/2 weeks

Acceptance of the requirement profile for the application
Customer specified time frame for the implementation
Customer specified target price and required quantity of prototypes and series'

STEP 2 **PROJECT SKETCH** approx. 0,5 week

Description of functionalities and requirements
Design concept
Draft of a schedule for project realisation

STEP 3 **REQUIREMENT SPECIFICATION** approx. 2 weeks

Definition of applicable documents and terminology
Definition of the requirements and of the system scope
Description of the system characteristics
>> **Development order**

STEP 4 **REALISATION OF THE PROTOTYPE** approx. 9 weeks

Calculations and simulations
Creation of the complete drawing with interfaces
>> **Release of the complete system by the customer**
Creation of drawings of individual parts
Creation of documentation for work packages and measurement protocols
Production or ordering of the product components
>> **Assembly of the prototype**
Implementation and qualification of the prototype
>> **Delivery**

STEP 5 **SERIES PRODUCTION** approx. 4 weeks

Integration and adaptation to new or unconsidered boundary conditions
Optimisation of individual parameters

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