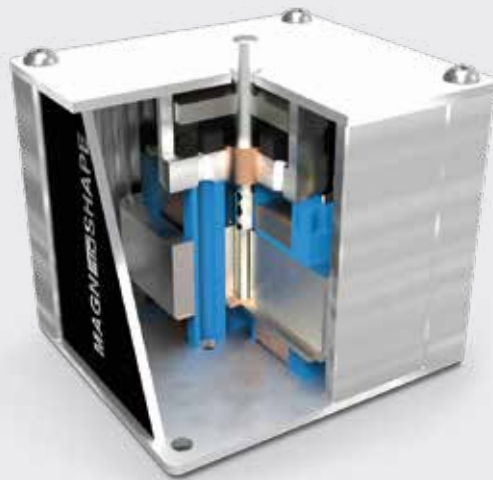


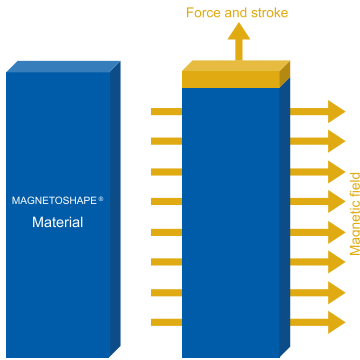
EIO GRUPPE
MOTION TECHNOLOGIES



MAGN **EIO** SHAPE

Magnetic Shape Memory Technology

Magnetic Shape Memory Technology Explained Briefly



Magnetic shape memory alloys are ferromagnetic materials that generate force and motion under moderate magnetic fields. The single crystalline alloys made from nickel, manganese and gallium are able to generate 6 % strain under external loads. They do this with frequencies into the low kilohertz range.

The magnetic shape memory effect was discovered in the mid-1990s. Over the past years, ETO has been carrying out intensive research in the area of the magnetic shape memory effect, significantly developing the material further and constructing actuators based on this. Today, ETO's new MAGNETOSHAPE® is ready for use in initial series applications. Thanks to its unique advantages, the technology has the potential to replace electromagnetic and other actuator technologies in future.

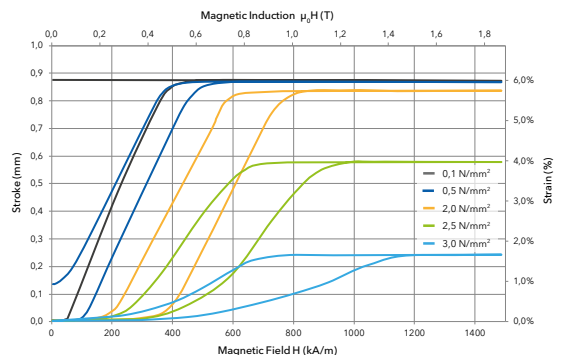
Manufacture of Single Crystal MAGNETOSHAPE® Material



- The raw materials are melted and alloyed inductively at around 1,400 °C
- Large single crystals are drawn using a modified Bridgman process
- The crystals are heat-treated for chemical homogenisation and adjustment of the microstructure
- The crystal orientation is determined using X-ray diffraction
- The crystals are typically cut into cuboid elements
- The elements are configured for the application

Technical Data of the MAGNETOSHAPE® Material

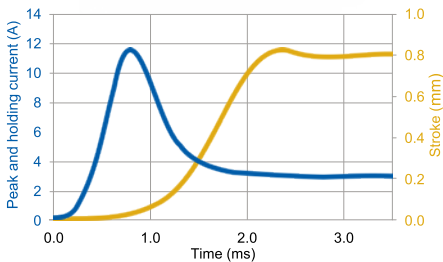
MAGNETOSHAPE®	
Alloy	NiMnGa
Field induced strain	6% under up to 2 N/mm ²
Blocking stress	Up to 3.5 N/mm ²
Switching field	0.6 T
Temperature limits	-40 °C - 60 °C
High cycle fatigue	2x10 ⁹ (material)
Typical element size	1 x 3 x 10 mm ³ to 6 x 6 x 30 mm ³
Magnetic permeability	2 (hard axis); 50 (easy axis)
Frequency	DC to 1 kHz
Switching speed	<1 ms (depending on actuator)



The Design Principles of MAGNETOSHAPE® Actuators

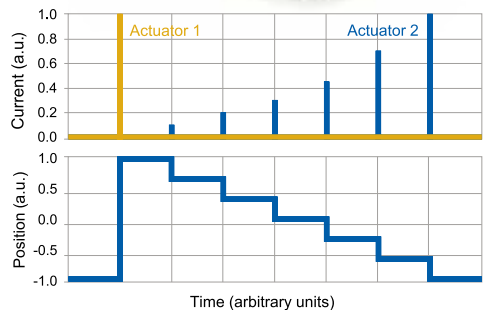
MAGNETOSHAPE® Spring Actuator

- Return spring working antagonistically to the MAGNETOSHAPE® element
- Extremely fast switching times (~ 1 ms)
- Bistable variant with permanent magnet possible
- Different magnetic circuits dependent on the required functionality (force, displacement, frequency)



MAGNETOSHAPE® Push-Push Actuator

- Two MAGNETOSHAPE® actuator units work antagonistically
- Energy-efficient multi-stability
- Intermediate positions are stable without power consumption
- Enables fast and precise position control (< 5 μm)



Benefits of MAGNETOSHAPE® Actuators

- Energy-efficient
- High work output at high frequencies
- Improved design of the actuator with low tribological wear
- Extremely fast switching characteristics
- Suitable for high service life applications
- Can be designed as bistable or multistable actuators, as well as monostable actuators with fail-safe functionality
- Can be thermally activated simultaneously
- Self-sensing ability

Non-Actuator Applications

MAGNETOSHAPE® smart materials can also be used for non-actuator applications. This is enabled by the inverse magnetic and thermal shape memory alloy effect.

- Measurement of position, speed, force, pressure etc.
- Energy harvesting for wireless energy supply
- Passive and active damping
- Use of specific alloys as high-temperature shape memory alloys (SMA)
- Thinned monocrystalline material for microsystem applications

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