PRINCIPLE

The Magnetostrictive Actuators are solid state magnetic actuators. A currentdriven coil surrounding the magnetostrictive rod generates the expansion of the rod. Magnetostrictive Actuators need a magnetic bias to present a linearised response, which can performed either by a DC current in the coil or permanent magnets.

Magnetic field induced strain materials are classically represented by Giant Magnetostrictive Materials (GMM) such as Rare earth-iron discovered by A.E.Clark. These materials feature magnetostrains which are two orders of magnitude larger than Nickel. Among them, bulk Tb0.3Dy0.7Fe1.9, called Terfenol-D, is commercially available since 1987 and presents the best compromise between a large magnetostrain and a low magnetic field, at room temperature. Positive magnetostrains of 1000 to 2000 ppm (0.1-0.2%) obtained with fields of 50 to 200 kA/m are reported for bulk materials, opening the possibility of building high power transducers and low voltage high force density actuators. More recently, the family of smart magnetic materials has been extended with Magnetic Shape Memory Materials (MSM) such as NiMnGa alloys offering a magnetostrain of up to 6%. These materials basically behave as Giant Magnetostrictive Materials.

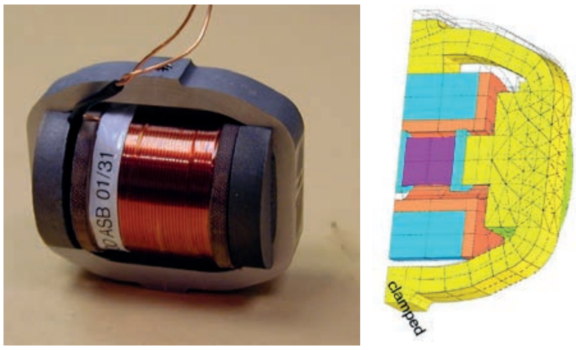

Fig. 1: Miniature Direct Magnetostrictive Actuator DMA XSLarge Direct Magnetostrictive Actuator DMA L.

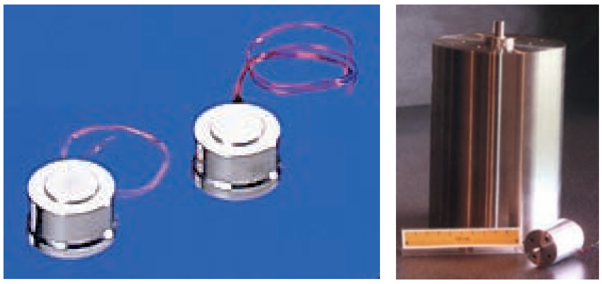

Fig. 2: Amplified Magnetostrictive Actuator AMA Modeling of the AMA magnetostrain with ATILA FEM.

DESIGN ISSUES

Magnetostrictive Actuators are complex structures needing a careful design, which can benefit of ATILA FEM for magnetostrictive and piezoelectric devices, from CEDRAT S.A. and of FLUX FEM software for magnetics. ATILA software allows 3D computation of the structure strain vs applied electric current accounting for magnetoelastic coupling:

- **Forces:** Magnetostrictive actuators can offer large forces because of high coupled stresses (up to 50Mpa) and availability of rods with large section (more than 50mm in diameter).
- **Stroke:** Stroke is governed by the expansion of the active rod and by its length (up to 200mm). Stroke can be amplified using a mechanical amplified such as a shell.
- **Voltage:** The excitation voltage can be adjusted using the coil number of turns. With high current and large section wires, the required magnetic field can be produced with a low voltage (less than 12V if needed).

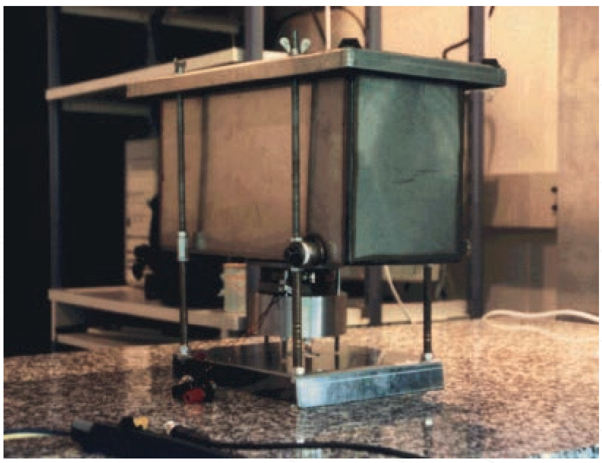

Fig. 3: High power (3kW) magnetostrictive sonar transducer TRIPODE.

www.cedrat-technologies.com | actuator@cedrat-tec.com www.cedrat-technologies.com | actuator@cedrat-tec.com

PERFORMANCES

Typical performances are given in the following table. This table is not exhaustive as many other actuators can be rapidly designed by Cedrat Technologies using its design tools, lab facilities and technological know-how.

REFERENCES	UNIT	SMA XS	DMA L	DMA XL
› **Notes**				
Stroke	µm	2	110	100
Maximal force	N	250	1570	21000
Maximal frequency	kHz	2	2	1
Voltage	V	12	12	12
Dissipated DC power	W	10	10	20
Diameter	mm	8	115	130
Height	mm	5	180	180
Mass	g	10	9300	12000
Electrical interface		2 wires AWG		

APPLICATIONS

Magnetostrictive Actuators are in strong competition with the standard piezo electric actuators such as PPAs and APAs from CEDRAT TECHNOLOGIES.

They find applications as sound generators (sonars), proportional valves, high forces generators or low voltage actuators (it can be less than 12V) ... They are used in machine tools, gas & petroleum industry, and are considered for medical, military and space industries...

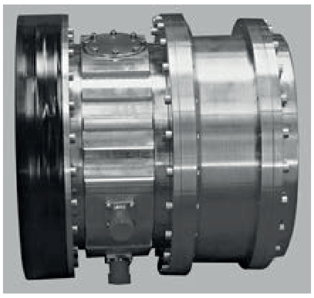

Fig. 4: Magnetostrictive transducerfor ultrasonic cleaning.

COLLABORATIONS, SUPPORTS

CEDRAT TECHNOLOGIES is partner of the FP6 EC MESEMA project with ALENIA, EADS, TACT, U.Naples, ZIP-LPA, ZFL.

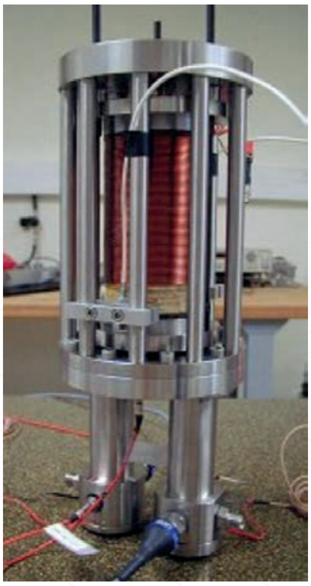

Fig. 5: Magnetostrictive actuator for makingan aircraft hydraulic pump in an Electro Hydraulic Actuator (EHA).