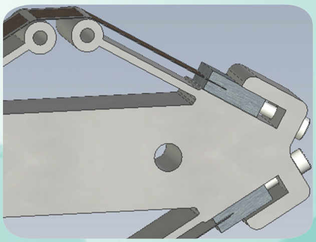


Electro-Active Polymers

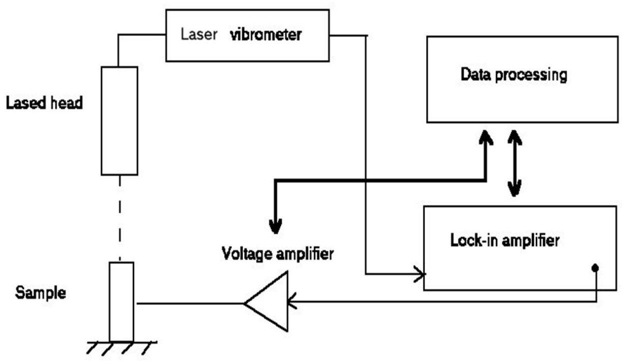
Electro-Active Polymers (EAP) receives growing interests due to some outstanding reported electromechanical performances. This may allow designing new active devices. Most of these outstanding performances (strain up to 300 %) have been reported on pre-tensioned devices. However, the two important limiting factors remain the pretty high required electrical field and the robustness of the electrodes. In the frame of MULTIPOL project, CEDRAT TECHNOLOGIES has studied the EAP and developed a dedicate test bench to characterize the material electro-activity.

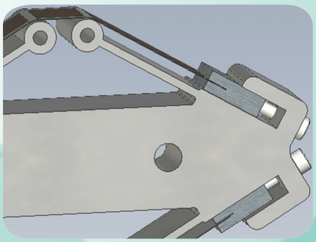
Introduction

EAP represent a relatively new class of smart materials including electronic polymers such as piezoelectric, dielectric or conductive polymers, and ionic polymers such as IPMC, ionic gels. EAP can exhibit very high deformations coupled with low forces. Electronics EAP can operate in room conditions for a long time and have a rapid response (mSec), it can also hold strain under DC activation and includes relatively large actuation forces. Unfortunately Electronics requires high voltages (~150MV/m), and compromise between strain and stress. The Ionics EAP have a large bending displacement, provides mostly bending actuation and requires a low voltage. But Ionics, except for CPs, do not hold strain under DC voltage. It's have a slow response (fraction of second). Demonstrators based on pre-stressed EAP can have the same design as Amplified Piezoelectric Actuators (APA™) for which CEDRAT TECHNOLOGIES has been working on since 15 years and owns a patent. The objective is to be able to completely characterize a new electro-active material.

Characterization bench

The measurement of the electrical or mechanical properties is conventional but measurement of the electromechanical coupling effect requires dedicated methods, to be able to link the electric field applied with the displacement it had generated in the material. This can be done by using a synchronous detection (SR830 apparatus) coupled to a displacement measurement as a laser interferometer, described below:



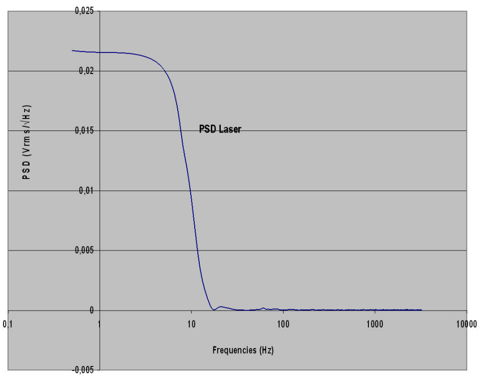


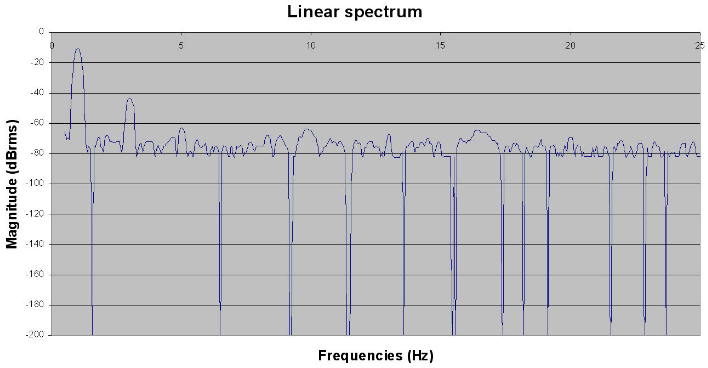
Electro-Active Polymers

Results

To have good results, some specific precautions had to be taken to be isolated from mechanical and environmental perturbations. To face these issues, the test bench was installed on an isolated marble table and a tube was put between the samples and the laser.

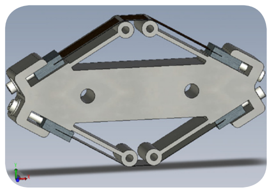
Between 20Hz and 400 Hz, the noise was at -61.19dB which involved a SNR at 72.16dB. The resolution is at 1/4055, which means a resolution as small as **5nm for a 20µm full scale displacement.**





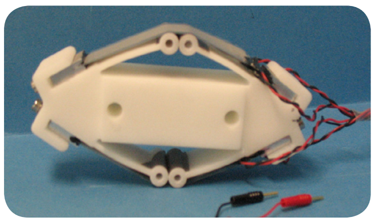
This test bench allows us to characterize an electro-active material with high resolution. In addition to the measurement of very small displacement in the nanometer range, the synchronous detection can also be used to measure non linear electromechanical effects.

Demonstrator



Demonstrators are made using piezoelectric PVDF EAP, Dielastomer EAP or other active materiel to characterize it.

Advantages /Specificities	Drawbacks/ Unknown consequences
Variable stiffness actuator / proof mass using the nonlinear behavior of the amplifying structure when reaching high amplification	Modeling feasibility using conventional software not established
Low cost & high displacement actuator / generator	Mechanical conversion efficiency may be very poor
Low stiffness actuator	Needed compliant electrodes
High damping actuator	
Use pre-stressed active material	



A demonstrator is inspired by our well known PZT based APA™ design adapted to use PVDF films. One of the main advantages of PVDF is that it offers high deformation capability, especially when used in thin strips. The PVDF strip is enrolled on a passive great axis part and used in d31 direction.

GROUPE CEDRAT

www.cedrat.com

For more information, please contact:

CEDRAT TECHNOLOGIES
15 Chemin de Malacher - Inovallée
38246 Meylan Cedex - France
actuator@cedrat.com
Phone: +33 (0)4 76 90 50 45 - Fax: +33 (0)4 56 38 08 30