Soft dielectric elastomers generators

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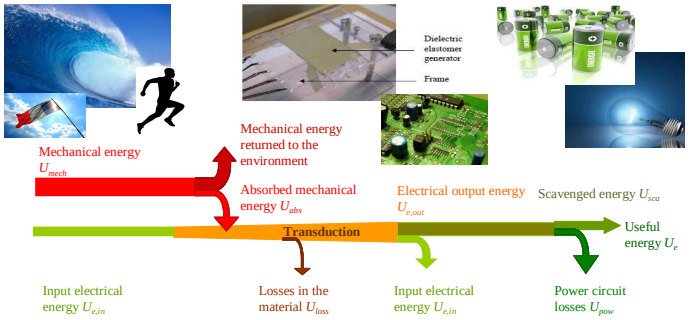
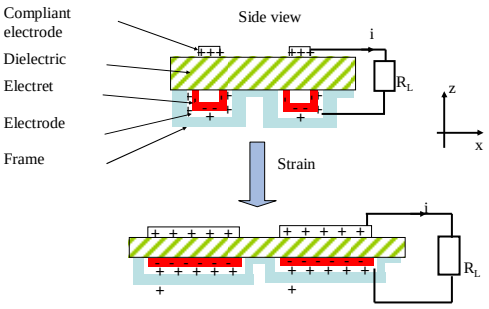
Objectives



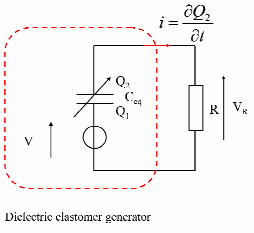
Dielectric elastomer generators (DEG) offer great potential for **soft applications involving fluid or human interactions**. These scavengers are light, compliant, have a wide-range of functions and develop an important energy density (1.7J.g^{-1}). Nevertheless, these systems are passive and require an external bias source. We focus our research on :

- **mechanical and electrical characterization of materials**
- **propose reliable electromechanical modelling**
- **design new transducers based on the use of electrets coupled with dielectric elastomer**

Concept of soft generator



Electret mode

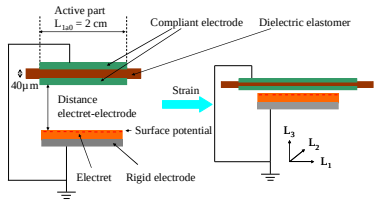


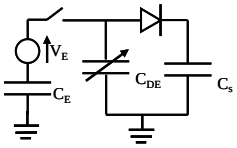
$$mL_{1a0}\frac{\partial^2\lambda}{\partial t^2} = -\left[2\frac{L_{20}L_{30}}{\lambda}\left(C_{10}+2C_{20}(I_1-3)+3C_{30}(I_1-3)^2\right)\left(\lambda^2-\frac{1}{\lambda^2}\right)\right]+\left[\frac{\partial}{\partial\lambda}\left(\frac{Q_2^2}{2C_{eq}}\right)\right]+F_{ext}$$

$$\frac{\partial Q_2}{\partial t} = \frac{V}{R} - \frac{Q_2}{R.C_{eq}}$$

$$\Rightarrow \quad P_{out} = \frac{1}{t_2-t_1}\int_{t_1}^{t_2} R\left(\frac{\partial Q_2}{\partial t}\right)^2 \partial t$$

Dielectric mode



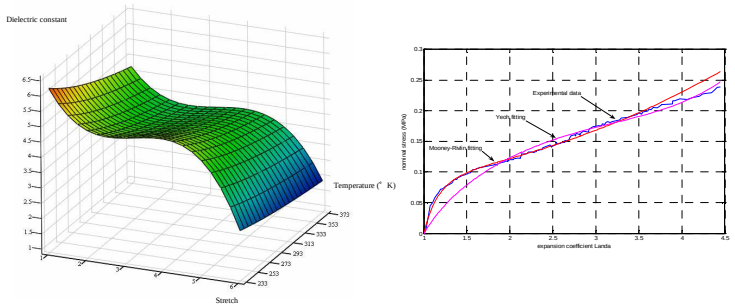


$$mL_{1a0}\frac{\partial^2\lambda}{\partial t^2} = \frac{L_{20}L_{30}}{\lambda}\left[-2(C_{10}+2C_{20}(I_1-3)+3C_{30}(I_1-3)^2(\lambda^2-\frac{1}{\lambda^2})+\frac{Q^2}{\varepsilon_0\varepsilon_r\lambda^2L_{1a0}^2L_{20}^2}+f_{ext}\right]$$

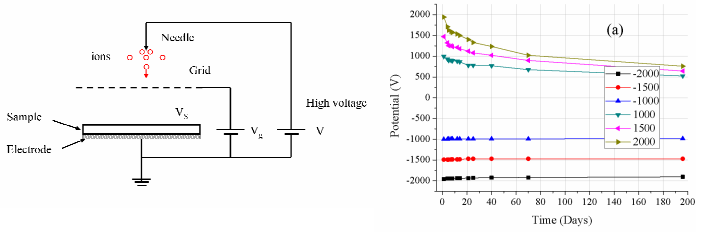
$$\Rightarrow \quad E_{pro} = \frac{1}{2}(C_DV_D^2 - C_CV_C^2)$$

Material Characterization

- Dielectric elastomers : spectrometry, video-extensometry…

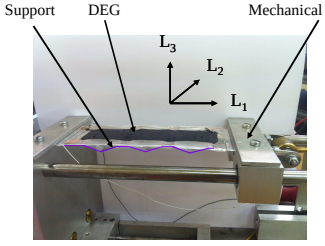


- Electret (corona discharge)

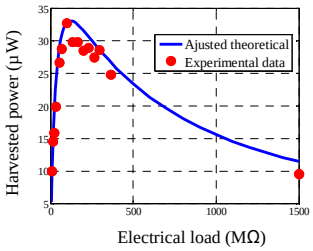


Test on the structure

Structure of 9cm per 2.5cm made of silicone Polypower and Teflon electret charged up to -1000V, strain of 50% at 1Hz.



Output voltage across electrical resistance R is recorded thanks to a electrostatic voltmeter



$\Rightarrow$ Energy density of 0.55mJ.g^{-1}

Conclusions and futur work

- Hybrid transducer: generator without bias voltage
- Promising scavenged energy density (0.55mJ.g^{-1})
- Wearable applications such as e-textile

- Tests of structures on dielectric mode
- Optimization of the strucures
- Modelization and test of complex realistic sollicitations

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