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Energy harvesting from a backpack with an auxetic dielectric elastomer generator

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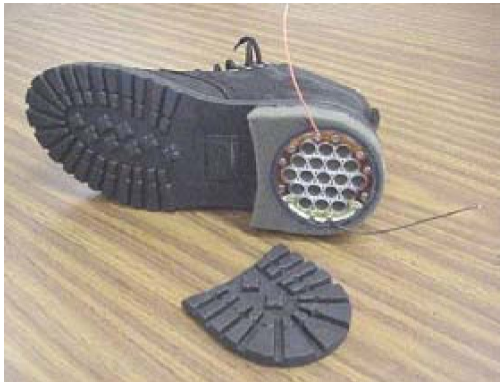
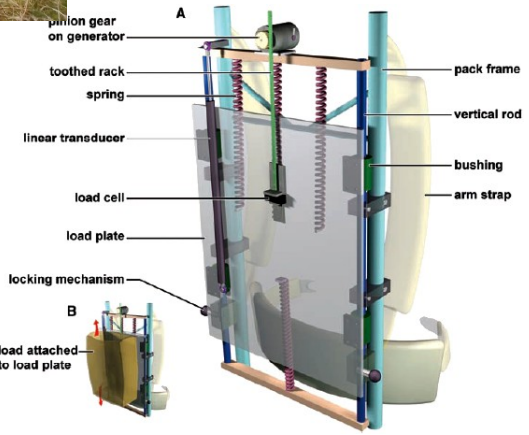
Walking has a great potential for biomedical energy harvesting

- **5W** walking at 1.5 m/s (**1.6kg**)
- **5 ± 21W** increase in metabolic cost

http://www.bionic-power.com/



- **0.8W** per shoe at 2Hz
- Lightweight



- **7.4W** carrying **38kg**
- Energy expenditure is increased of about **3.2%**

[1] J. M. Donelan, Q. Li, V. Naing, J. Hoer, D. Weber, and A. D. Kuo, "*Biomechanical energy harvesting: generating electricity during walking with minimal user effort*" Science, vol. 319, no. 5864, pp. 807-810, 2008.
[2] Kornbluh, Roy D., Joseph Eckerle, and Brian McCoy. "*A scalable solution to harvest kinetic energy*" *SPIE Newsroom* (2011).
[3] L. C. Rome, L. Flynn, E. M. Goldman, and T. D. Yoo, "*Generating electricity while walking with loads*" Science, vol. 309, no. 5741, pp. 1725-1728, 2005.

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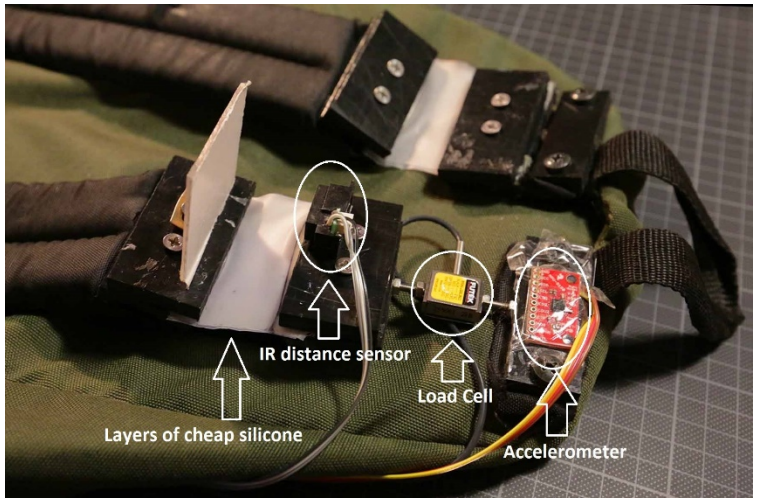
Research focus

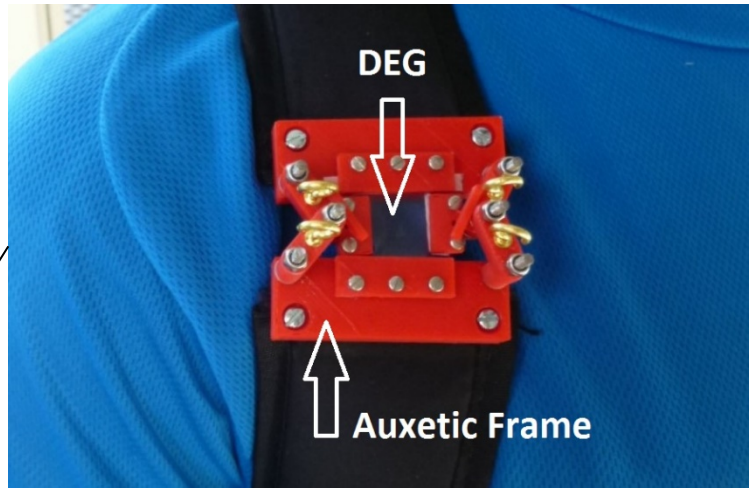
Develop a Dielectric Elastomer Generator (DEG) able to harvest energy from the stretch of the backpack straps without impairing the user movement or providing additional load over that of a conventional backpack as the present energy harvesting systems usually do.

Instrumented backpack



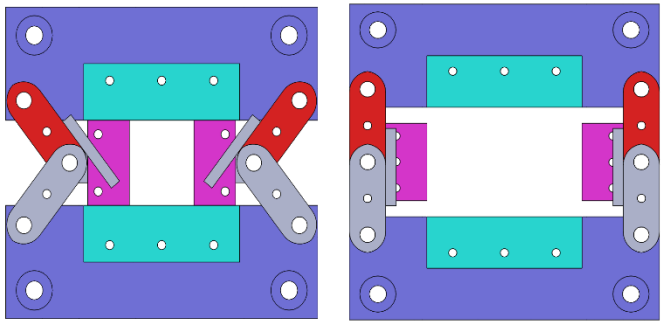
Mechanical energy available in the backpack straps is high enough to scavenge some significant power
Stretch 45% carrying 11Kg

Bowtie auxetic frame



Converts a uniaxial solicitation in a biaxial deformation of the DEG

26.8μW at 1kV



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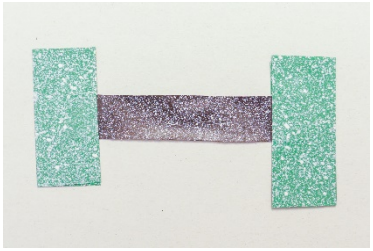
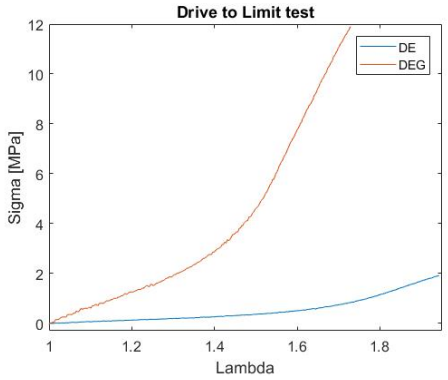
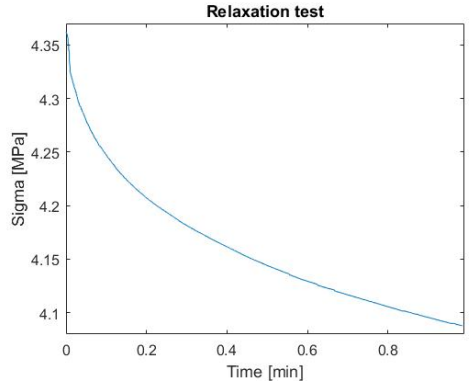
DEG Characterization

Mechanical:
Uniaxial Tests + Video Extensometer



Test sample dimension: width 1cm; length 5cm (ISO 527-2)





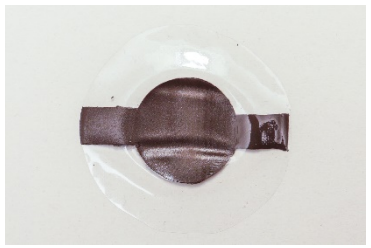
εmax = 73%
εmax > 45%

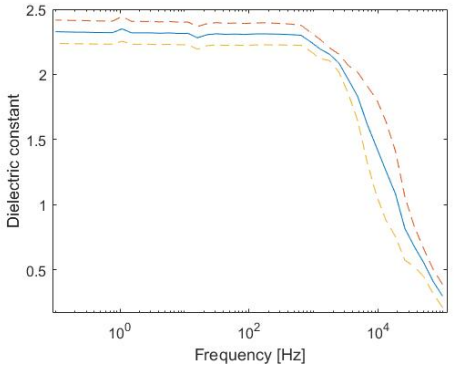
Parameter	Ref	DEG
ε'_r @ 0.1Hz	2.68	2.3
ε'_r @ 10^5Hz	2.61	0.3
ε'_r @ 1-2Hz	2.66	2.29
tan δ@ 0.1Hz	$324*10^{-4}$	$75*10^{-4}$
tan δ@ 10^5Hz	$93*10^{-4}$	$179*10^{-2}$
tan δ@ 1-2Hz	$41*10^{-4}$	$27*10^{-4}$

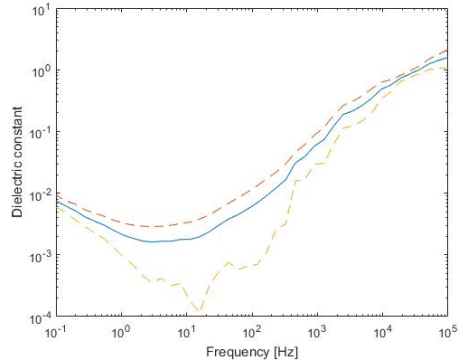
Neglegible viscous losses (6.16% in 1')

Electrical
Dielectric spectroscopy

Test sample dimension: Øelectrodes 28mm; Ødielectric 55mm







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Thank you!