Variable Stiffness Suspension

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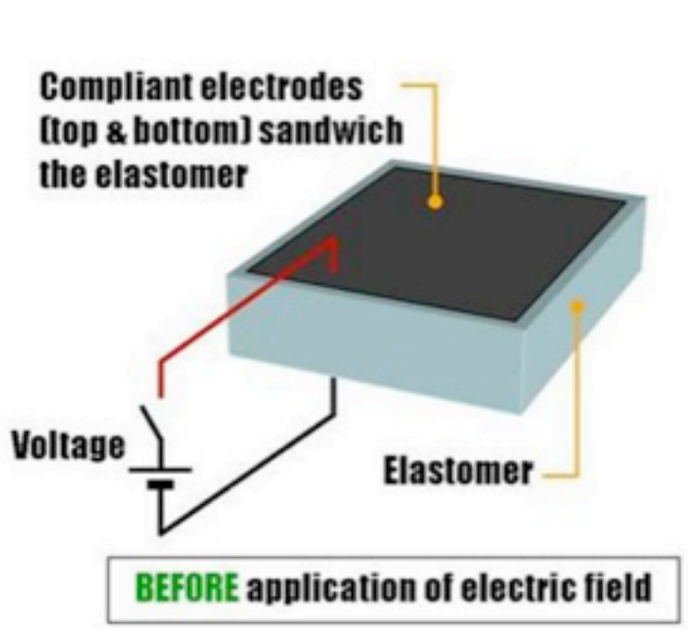
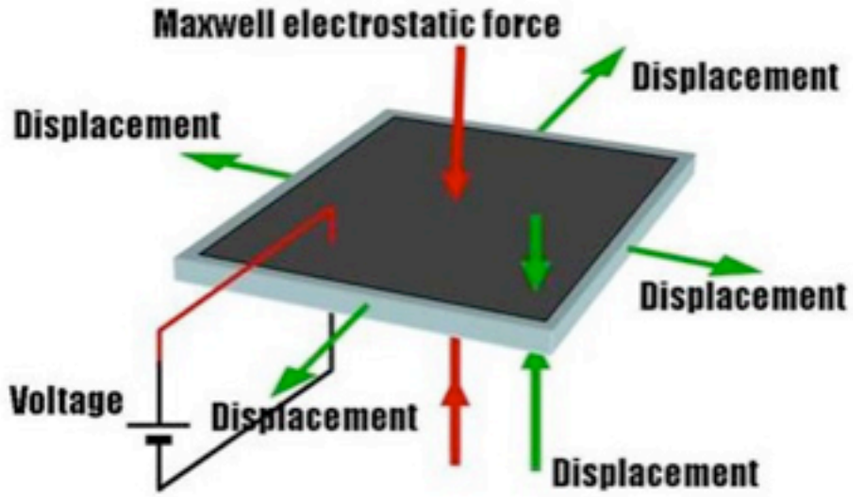
Honda Project Goal

Factors	Reasons	Target Value for Asimo's Elbo
Wider stiffness range	Compatibility of Softness and Accuracy of move	200 – 800 Nm/rad
Change stiffness in real time	Maximum force is often occurred within 50ms in experimental robot collision data	Within 50ms
Lighter weight of device	Device weight affects linearly the energy of disturbance	Within 200g (device only)
Larger deflection of stiffness	To raise up the energy absorbance while collision	7 degree

Electroactive Polymer



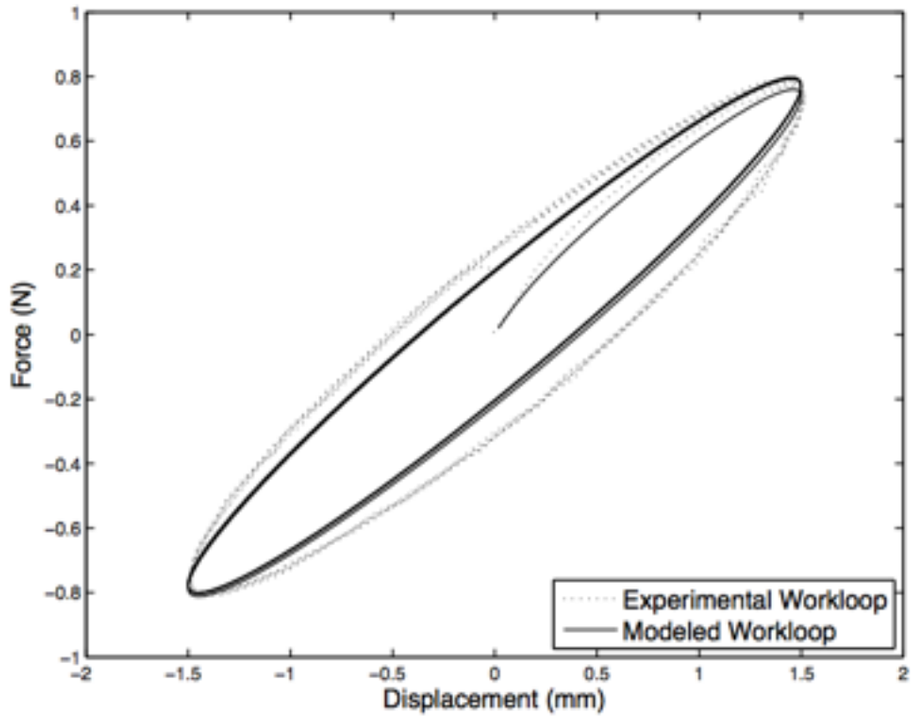
BEFORE application of electric field



ON application of electric field

Dielectric

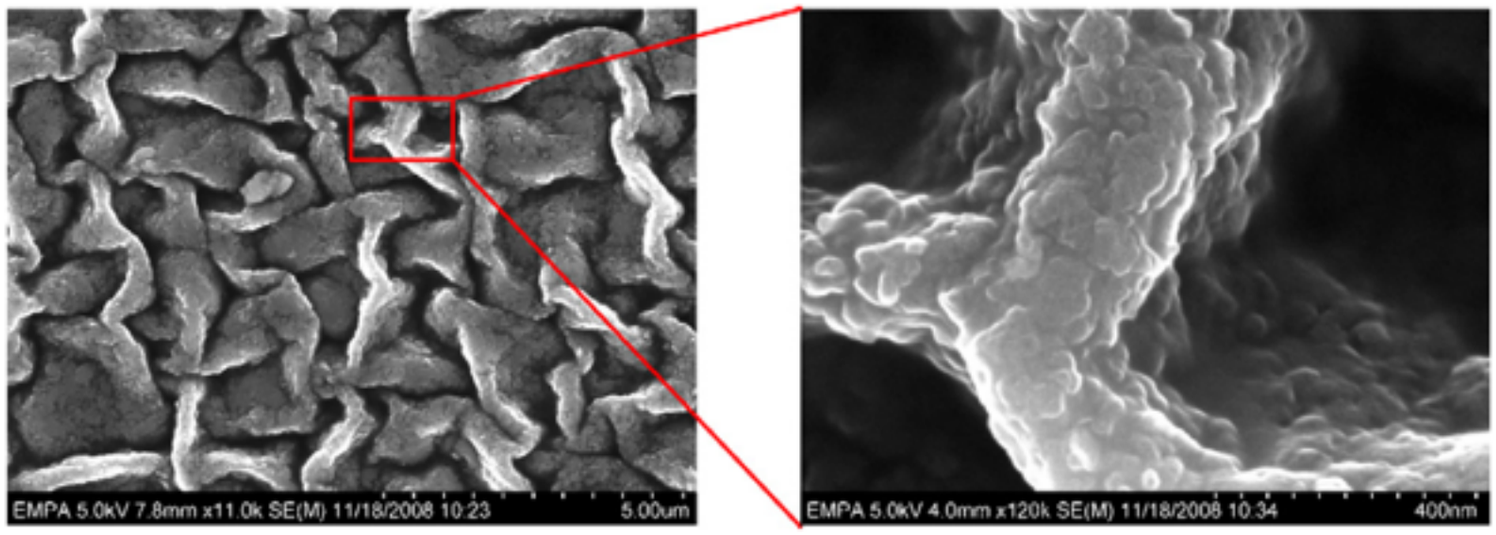
- Stretched acrylic
  - High energy density
- Silicone
  - Low viscoelasticity (small hysteresis)



Electrode Layer

- Conductive carbon silicone grease (current method)
- Cured silicone rubber and carbon mixture
- Carbon particle (scatter and suction cleaning)

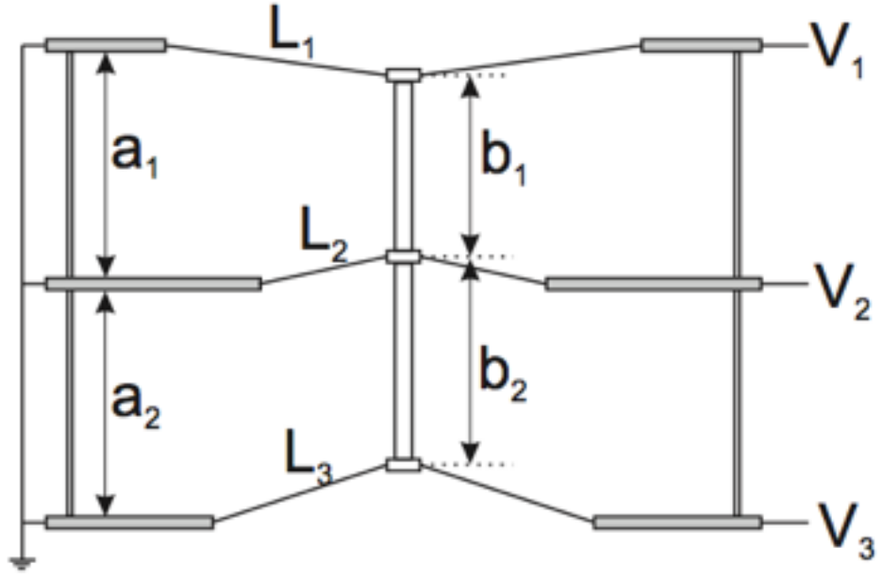
G. Kovacs et al. / Sensors and Actuators A 155 (2009) 299–307

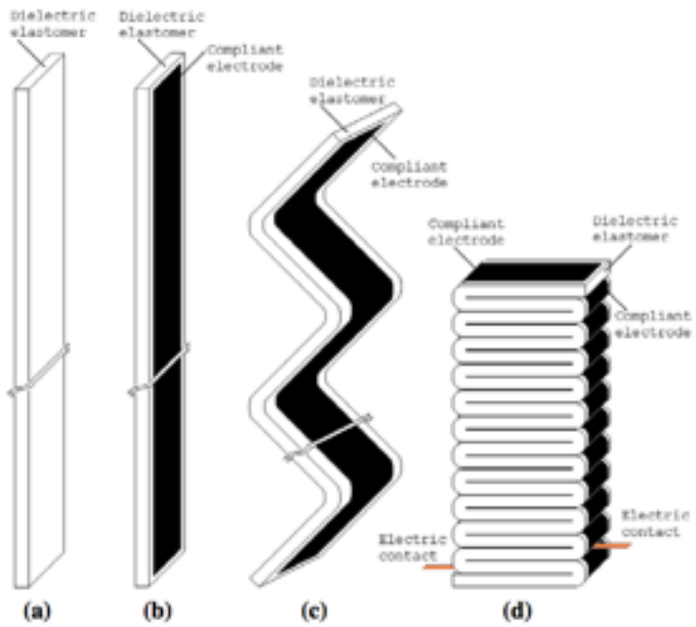


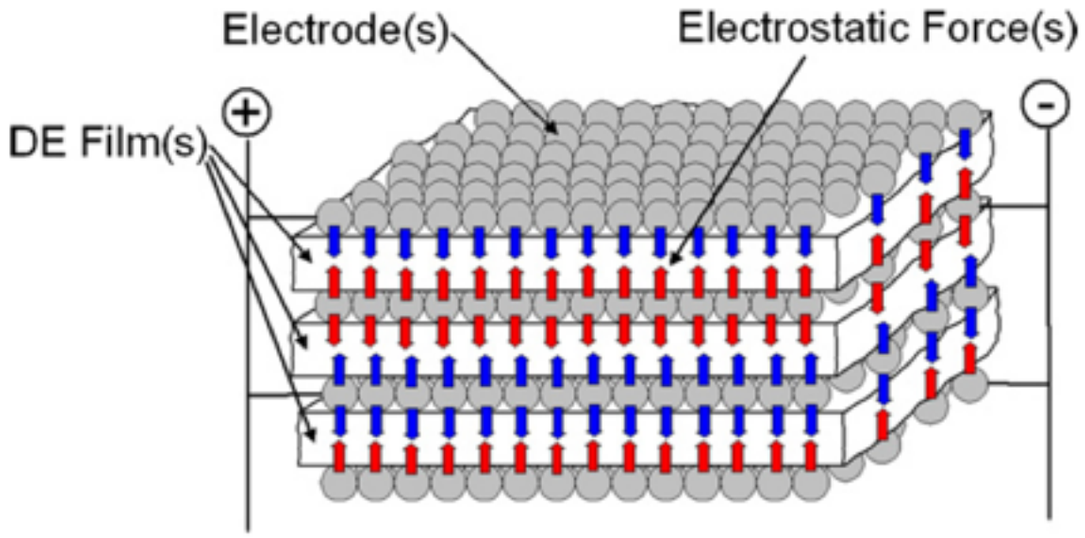
Morphology of the electrode surface on a relaxed dielectric elastomer film. General overview (left) and detail of the particle cluster.

Multi-layer

- Stacked
- Pile-up
- fold up
- Glue up

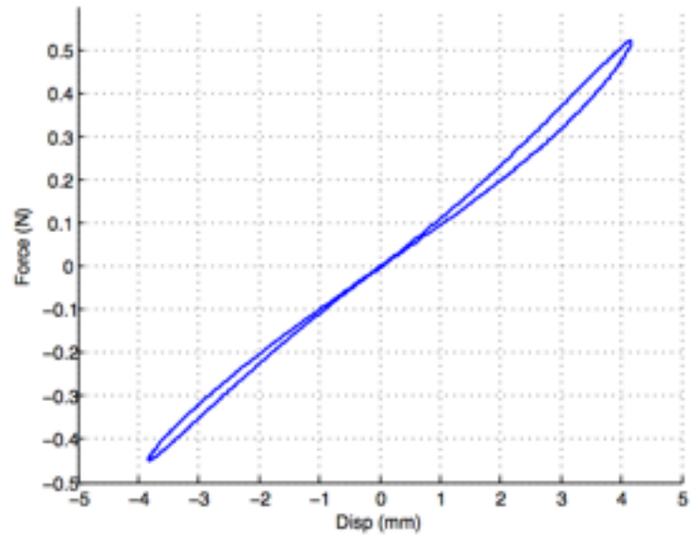


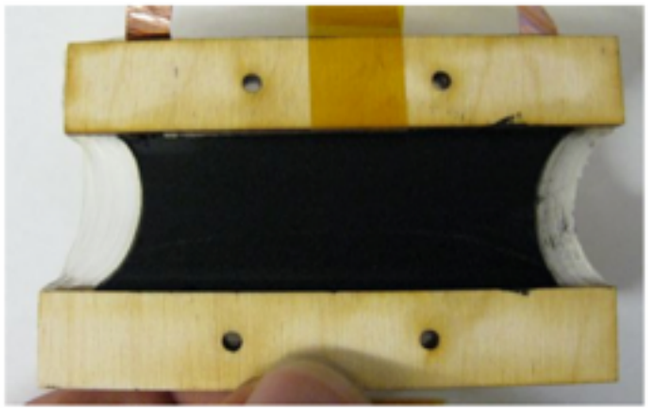


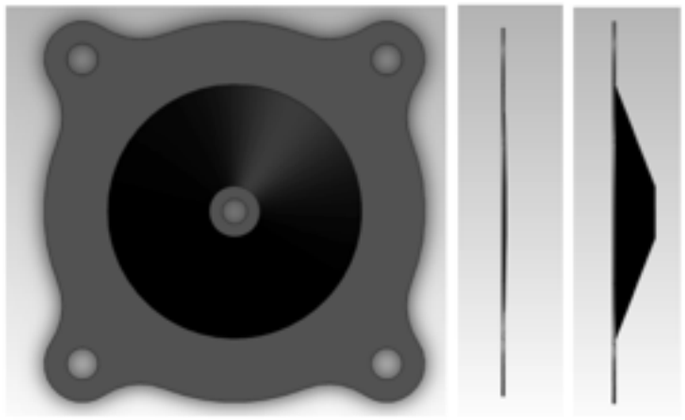


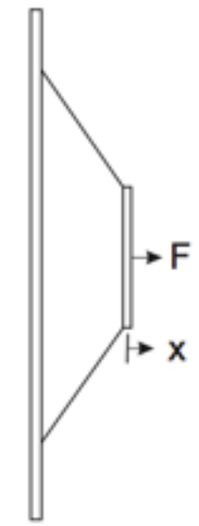
Suspension

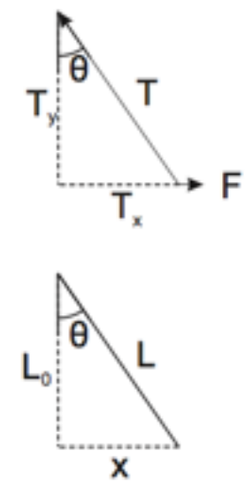
- Energy storage
  - High energy density
- Low hysteresis
  - Low strain (7%)
- Configuration











Design Criteria

- EAP volume
- 7% strain well-distributed (maximum displacement)
- Manufacturability

Plan

- Manufacture
  - Dielectric: acrylic film
  - Electrode: cured carbon-silicone electrode
  - Try 3M conductive cover tape

Possible Design