

# Electroactive properties of elastomers: finite element method modelling and experimental results

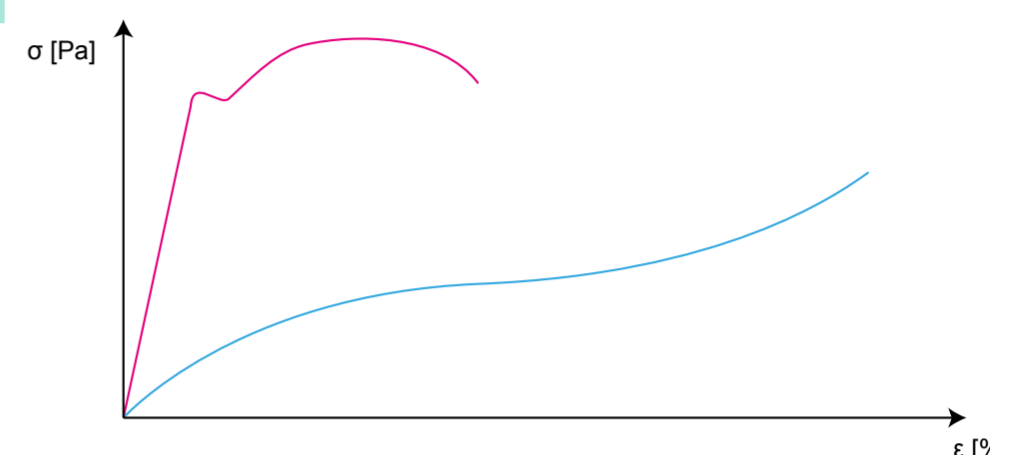
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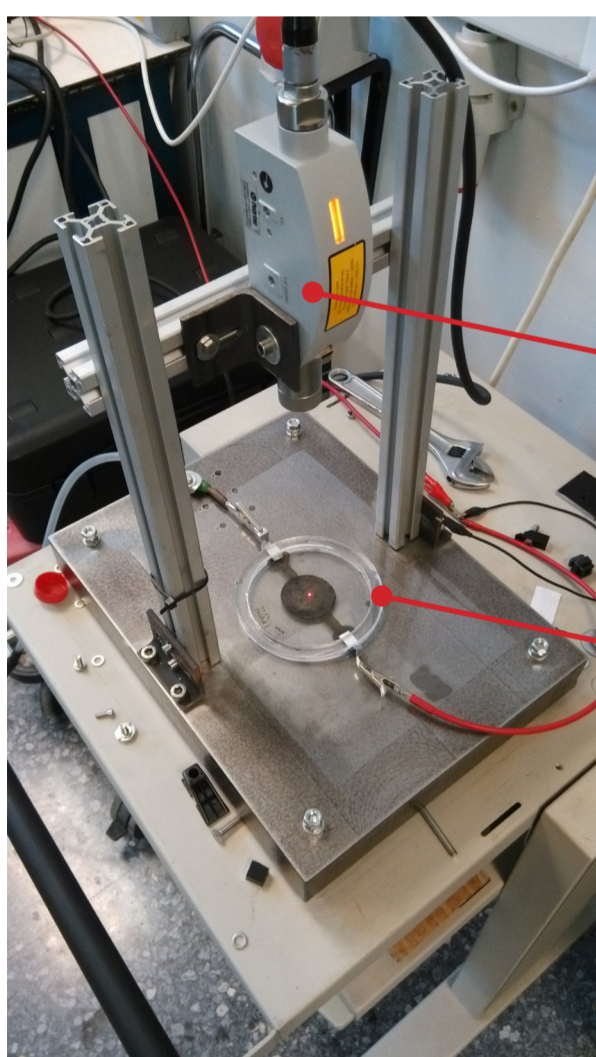
## Problem definition

Dielectric elastomer actuators (DEAs) have a non-linear strain-stress relation which make them difficult to predict. Numerical methods offer a way to better analyse their behaviour. In this study, a finite element model based on the Ogden equation of free strain energy density is made in Comsol Multiphysics. Next, different displacement measurements were made using a laser vibrometer, AC/DC superimposition and digital imaging. Finally, a comparison is made between the results of the tests and the finite element model.



Stress-strain curves of a typical steel (red) with a linear section and an elastomer (blue) which is non-linear.

## Test setup

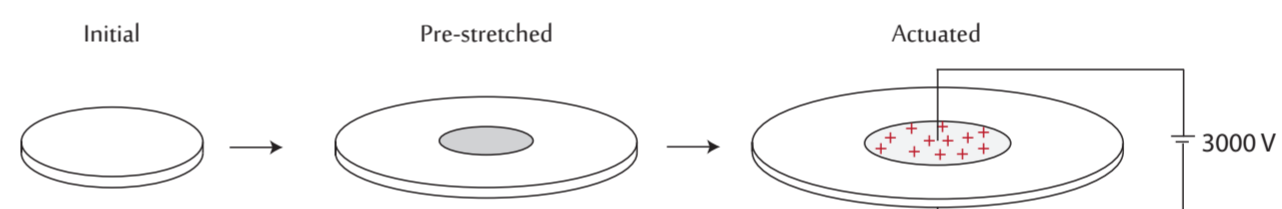


Vibrometer/  
camera

DEA

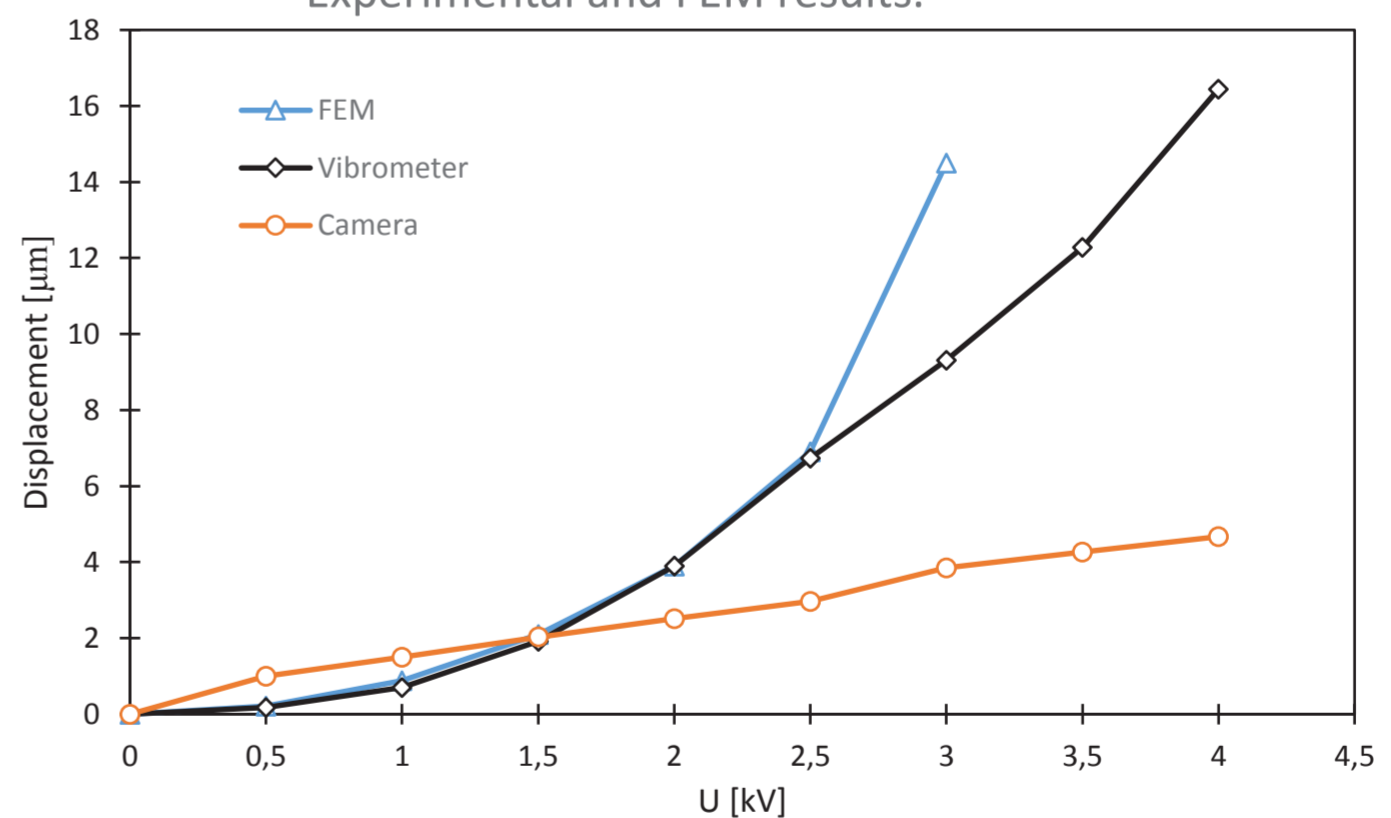
## DEA working principle

A piece of 3M VHB 4910 acrylic tape acts as the medium of the DEA. Starting off with a piece of 25 mm by 25 mm, the tape is pre-stretched until 4,4 times its size to improve actuation characteristics. Afterwards, two patches of carbon black are applied, which act as the electrodes. When a potential is put on the electrodes, the DEA will vary its thickness.



## Test results

Experimental and FEM results.



## Conclusion

Firstly, up until 2,5 kV the Ogden model fits the vibrometer experimental data. When the voltage is higher than 2,5 kV, the model deviates significantly. This might be explained by the variable concentrations of carbon black, which cause defects in the electrostatic field. In order to have a better fit, the Ogden parameters could be further optimized. Secondly, due to the very low intrinsic capacity of the DEA, the AC/DC superimposition proved to be unsuccessful.