The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

Programming shape-morphing of dielectric elastomers through Multifunctional Topology Optimization

J. Martínez-Frutos*[1], R. Ortigosa[2] and A. J. Gil[3]

[1] Technical University of Cartagena, Campus Muralla del Mar, 30202, Cartagena (Murcia), Spain. jesus.martinez@upct.es

[2] Technical University of Cartagena, Campus Muralla del Mar, 30202, Cartagena (Murcia), Spain. rogelio.ortigosa@upct.es

[3] Zienkiewicz Centre for Computational Engineering, College of Engineering, Swansea University, Bay Campus, SA1 8EN, United Kingdom. a.j.gil@swansea.ac.uk

Keywords: *dielectric elastomers, topology optimization, nonlinear electro-mechanics, shape morphing*

This paper presents a topology optimization framework for the design of shape-morphing dielectric elastomers (DE) undergoing complex electrically induced deformations. Two different mechanisms are explored to induce Gaussian curvature changes. The first one aims at creating an inhomogeneous electric field inside the DE through the careful design of spatially varying internal electrode meso-architecture, yielding inhomogeneous actuation modes. The second one explores the use of TO techniques with the aim of designing a spatially varying distribution of stiffeners, namely, passive material devoid from electro-mechanical properties, yielding an anisotropic response of the material. A series of proof-of-concept examples (in both circular and squared geometries) are presented in order to demonstrate the robustness of the methodology and its potential as a new tool for the design of new DE-inspired soft robotics components. The ultimate objective is to help thrive the development of this technology through the in-silico production of voltage-tunable (negative and positive Gaussian curvature) DEs shapes beyond those obtained solely via trial-and-error experimental investigation.

First and second authors acknowledge the support provided by the Autonomous Community of the Region of Murcia, Spain through the programme for the development of scientific and technical research by competitive groups (20911/PI/18)

REFERENCES

[1] J. Martínez-Frutos, R. Ortigosa, A.J. Gil, In-silico design of electrode meso-arquitecture for shape morphing dielectric elastomers. *J Mech Phys Solids*, Vol. **157**, 2021.

[2] R. Ortigosa, J. Martínez-Frutos, Topology optimisation of stiffeners layout for shape-morphing of dielectric elastomers. *Struct Multidisc Optim*, Vol. **64**, pp. 3681–3703, 2021.