HYDROGEL-ACTUATED MORPHING IN LATTICE METASTRUCTURES: IGA-BASED SIMULATIONS AND EXPERIMENTS

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EXTENDED ABSTRACT

Thanks to their hydrophilic nature, hydrogels undergo a huge volumetric expansion when in contact with water [1]. Such a large volume increase can be exploited to obtain pressure forces suitable for driving the shape change of so-called responsive structures **Errore. L'origine riferimento non è stata trovata.**. Further tuning possibilities arise when temperature-sensitive hydrogels are concerned, enabling to control the obtainable morphing by playing with temperature [3].

Among the wide range of morphing possibilities offered by the use of hydrogels, their interaction with elastic structures represents a new strategy to obtain unthetered morphing elements. In particular, the use of elastic metamaterials represents a simple strategy to obtain responsive structures whose responsiveness comes from their geometrical and topological design.

In the present study, we propose the use of hydrogel beads embedded in a tube with a lattice metastructure aimed at driving a desired shape change of the system. By properly designing the local characteristic of the metastrucure (organization and size of the lattice elements), a precise 3D morphing can be achieved. Numerical simulations based on a large deformation isogeomoetric analysis (IGA) model and experimental results are presented and compared.

The proposed strategy opens a new path in creating responsive elements and devices to be used in a variety of applications ranging from medicine to autonomous robots.

***Keywords**:* Hydrogels; Swelling-driven actuation; Lattice Metamaterials; IGA beams; Morphing.

REFERENCES

[1] Yang, D. (2022). Recent advances in hydrogels. Chemistry of Materials, 34(5), 1987-1989.

[2] Li, H., Bartolo, P. J. D. S., & Zhou, K. (2025). Direct 4D printing of hydrogels driven by structural topology. Virtual and Physical Prototyping, 20(1), e2462962.

[3] Tang, L., Wang, L., Yang, X., Feng, Y., Li, Y., & Feng, W. (2021). Poly (N-isopropylacrylamide)-based smart hydrogels: Design, properties and applications. Progress in Materials Science, 115, 100702.