

Project title:

Hydrogel Ionotronics for Soft Robotic Applications

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PARTNER INSTITUTIONS:

From China:

- College of Mechanics and Materials, Hohai University, Nanjing, China.

From Serbia:

- Mathematical Institute of the Serbian Academy of Sciences and Arts, Belgrade, Serbia,
- Faculty of Mechanical Engineering, University of Belgrade, Serbia.

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PROJECT DESCRIPTION:

Amid the frontier of emerging soft machine technology, the advancement of wearable and implantable devices via soft sensors and actuators has surged to the forefront of research interest. Hydrogel-elastomer composite materials offer a unique flexibility, biocompatibility, and responsiveness that ideal for human-machine interface devices. The transformative potential of soft, flexible materials is reshaping technology across healthcare, robotics, and more. This convergence of biology, materials, and robotics leads to wearable interfaces with novel functions. Sensors and actuators, essential for human-machine interaction, require thoughtful design for optimal adaptation. Our project aims to design advanced mathematical models to simulate the behavior of such hydrogel-based composite sensors and actuators. We will merge theory, computation, and results from experiments to overcome these challenges and develop reliable predesign procedures for such fit-for-purpose devices. Within the realm of hydrogel ionotronics, our emphasis lies on hydrogel-elastomer composites with the exceptional capacity to convert mechanical stimuli into electrical signal and vice versa. We aim to develop improved electro-chemo-mechanical computational models capable of capturing complex behavior of hydrogel-based composites. A special attention will be given to the development of novel models of multicomponent and cross-diffusion in hydrogels based on fractional derivatives along with the development of efficient numerical methods to simulate intricate actuator/sensor responses. Our goal is to build a strong scientific collaboration between the Serbian and Chinese teams in this challenging research area, with the potential to develop reliable software tools for creating practical soft ionotronic sensors in the future.