Title: Stimuli-Responsive Materials for Sensors and Actuators in Soft Robotic Applications

Abstract: Soft robots, designed to manipulate objects with a level of dexterity comparable to living organisms, require highly compliant sensors and soft actuators to ensure precision and adaptability in their operations. Mimicking the sensorimotor functions of biological systems facilitates the development of exceptionally sensitive physical sensors and soft actuating bodies driven by sensory feedback. Inspired by the structures and functions of biological organisms, we designed hierarchical ZnO nanowire arrays and developed electronic skins capable of detecting both static and dynamic stimuli, similar to skin mechanoreceptors. The effective stress transmission of microridge structures between the epidermis and dermis provided significant insights for designing spacer-free and wearable triboelectric sensors for motion tracking. Furthermore, we developed the highly compliant and printable magnetic paste for flexible magnetic-field sensors, thereby extending proximity sensing capabilities beyond human sensory perception. Finally, we demonstrated soft, hingeless, and intelligent magnetic origami actuators that allow shape-reconfigurable and self-controllable actuation by just guiding light and magnetic field. The proposed sensors and actuators, based on stimuli-responsive materials that respond to mechanical stress, electric/electromagnetic fields, and a variety of other energy sources, enable robots to perform tasks with remarkable precision and autonomy.