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Hydrogel nanocomposite photoactuator for direct optical to mechanical energy conversion obtained by ionizing irradiation

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The incorporation of suitable nanomaterials into the stimuli responsive hydrogel matrix enables the hydrogel nanocomposites to become a key soft component of new generation of soft electronic and soft robotic devices1,2. An energy transformation agent, functional gold nanoparticles and nanorods exhibit unique photo-thermal properties as a result of a surface plasmon resonance electron-phonon process and intrinsic inter-band transitions. Upon immobilization in thermo-responsive hydrogel, they induce local photo-thermal shrinking under visible light irradiation and thus enable external wireless remote control of hydrogel device and programmable photo-thermo-mechanical motion. In addition, in this way control of interface conductivity can be realized by switching hydrogel nanocomposites between electrically communicating and non-communicating states.

In this work, a soft photo/thermal reversible hydrogel nanocomposite device consisting of gold nanoparticles or nanorods embedded in poly(N-isopropylacrylamide) (PNIPAM) and poly(N-isopropylacrylamide) (PNIPAM)/poly(vinyl alcohol) (PVA) bilayer structure (in order to maximize shape changes), were developed using nanotechnology based on radiation chemistry. The key parameters deciding the actuation characteristics as well as conductivity and percolation threshold, particle diameter and shape as well as interparticle distance, can be easily tailored during synthesis using radiation processing technology. Obtained hydrogel nanocomposite device with wireless remote actuation and electrical control has great potential for light-harvesting and mechanical motion which is required for the construction of soft smart actuator systems for applications in soft robotics, for dense information storage and efficient energy conversion.