Electroactive nanomaterials and their composites for smart responsive soft electronics

Pooi See Lee

School of Materials Science and Engineering

Nanyang Technological University, Singapore

pslee@ntu.edu.sg

Smart responsive soft electronics are desirable applications in human machine interface or autonomous artificial intelligence systems. Utilizing electroactive materials provide vast opportunities to tailor unique properties with multiple functionalities. Further incorporating these electromaterials into supramolecular polymers lead to synergistic coupling of electrical and mechanical properties for soft electronics. One of our strategy focuses involves the preparation of supramolecular composites with the addition of electromaterials into supramolecular polyurethane for self-healable stretchable conductors. The resultant carboxylated polyurethane matrix with hard domain and soft brush impart hydrogen bonding renders efficient self-healability. The conductive metallic fillers and addition of liquid metal particles ensued electrons conduction pathways upon high stretchability. The supramolecular composite has been shown to serve as a good current collector for stretchable battery as it provides a stable electrochemical window using ionic liquid as the electrolyte.

With direct laser patterning method, we design and fabricate vertical electroactive rGO/Au bilayer heterostructures for stretchable conductors for microsupercapacitors. The vertically oriented rGO array was fabricated by high repetition rate femto-second pulse irradiation, subsequently covered with a thin Au layer and transferable into elastomeric substrates. The rGO/Au/PDMS exhibits high conductivity and stretchability, providing a conductivity of ~105 S m−1 and maintains ~104 S m−1 at a strain of 50%. This is attributed to the low junction resistance created by the heterostructure and the 3-D connected network that reduces the contact loss upon stretching. A fast charge/discharge rate and high-frequency response microsupercapacitor can be achieved even during omnidirectional stretching. The intrinsically stretchable and patterned electrodes can be implemented in numerous applications including interactive wearable devices, human-machine interfaces and smart robotics. Additional examples of electroactive nanomaterials for responsive actuators will be illustrated in this talk.