seminar

SEMTE

"Warm-blooded Plastics" Bio-inspired Solutions to Smart Energy Conversions

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abstract

Creating systems that effectively convert energy, such as efficient solar cells and electrochemical batteries, has been a longstanding scientific pursuit, especially given the global energy challenges nowadays. But from a biological perspective, the interplay between the electrical or chemical stimuli, the solar energy from sunlight, and the mechanical motion is commonplace, indeed fundamental, to nature's abilities of self-regulation via the effective energy harvesting and conversion on both a microscopic and macroscopic level. Warm-blooded animals and many living organisms exhibit unique homeostatic abilities, maintaining tight control of their local environment (temperature, pressure, etc.) through efficient interconversions of chemical and mechanical energy via self-regulating feedback loops. In contrast, most man-made materials lack this capability. Applying the concept of homeostasis to the design of autonomous materials would have substantial impacts in areas ranging from 'smart' materials that regulate energy usage in batteries or energy-efficient buildings to medical implants that help stabilize bodily functions. This talk will present a versatile strategy for creating self-regulating, self-powered, homeostatic materials capable of precisely tailored chemo-mechano-chemical feedback loops on the nano- or micro-scale. The exemplary autonomous, self-sustained polymer-based material systems "SMARTS" are able to maintain a user-defined parameter, for example temperature, in a narrow range, by employing a continuous feedback loop between various catalytic reactions and the mechanical action of the environmentally-responsive material hydrogel. This broad-based energy-converting platform is highly customizable owing to the broad choice of chemistries, tunable mechanics and its physical simplicity. Perspectives on the nature-inspired solutions for may impact future applications in energy and biomedicine will be discussed, from "smart energy devices" of sunlight harvesting beneficial for solar cells, thermo-voltaics as counterparts of photovoltaics, photo/electro-chemical converters, to "energy-efficient biomedical materials" in glucose self-regulating implants.

biosketch

Ximin He is a postdoctoral research fellow in the Wyss Institute of Bioinspired Engineering and School of Engineering and Applied Science at Harvard University. She received her PhD in Chemistry in the fields of Nanoscience and Organic Optoelectronics from University of Cambridge, Melville Laboratory for Polymer Synthesis, Cavendish Laboratory and Nanoscience Center. Dr. He's research focuses on smart materials, organic optoelectronics, as well as biologically inspired engineering technologies with applications in materials science, biomedicine, and energy. She has authored/co-authored 19 papers in leading archival journals and peer-reviewed conference proceedings, a book chapter and has a number of pending U.S./U.K. patents. Dr. He is the recipient of the Gates Cambridge Scholarship, UK Overseas Research Scholarship, the Government Award for National Outstanding Students, and National Excellent Young Scientist Award by the W. Wing Yip & Brothers Bursaries. Her research on novel nanostructured polymeric solar cells and bioinspired synthetic homeostatic materials have garnered a number of regional and international Best Student Paper awards and Best Poster award in the MRS meeting, and was featured in >100 international news outlets, including The Times, BBC, and Nature.

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