Self-powered all weather sensory systems powered by Rhodobacter sphaeroides protein solar cells

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Abstract
Natural photosynthetic proteins can convert solar energy into electrical energy with close to 100% quantum efficiency, and there is increasing interest in their use for sustainable photoelectrochemical devices. The primary processes of photosynthesis remain operational and efficient down to extremely low temperatures, and natural photosystems exhibit a variety of self-healing mechanisms. Herein, we used an amphiphilic triblock copolymer, Pluronic F127, to fabricate a self-healing photosynthetic protein photoelectrochemical cell that operates optimally at sub-zero temperatures. A concentration of 30% (w/w) Pluronic F127 depressed the freezing point of an electrolyte comprising 50 mM ubiquinone-0 in aqueous buffer such that optimal device solar energy conversion was seen at −12°C rather than at room temperature. Fabrication of the protein photoelectrochemical cells with flexible electrodes enabled the demonstration of self-healing of damage caused by repeated mechanical deformation. Multiple bending cycles caused a marked deterioration of the photocurrent response to around a third of initial levels due to damage to the gel phase of the electrolyte, but this could be restored to ~95% by simply cooling and rewarming the device. This self-recoverability of the electrolyte extended the operational life of the protein cell through a process that increased its photoelectrochemical output during the repair. Utility of the cells as components of a touch sensor operational across a wide temperature range, including freezing conditions, is demonstrated.

Nikita received her bachelor’s degree in Department of Ceramic Engineering from National Institute of Technology, Rourkela. She is currently a PhD candidate in Department of MSE under Asst. Prof. Tan Swee Ching, focusing on exploiting photosynthetic proteins for solar energy conversion and storage devices.

ALL ARE WELCOME!
Host: Asst. Prof. Pieremanuele Canepa