Transparent PEDOT:PSS Based Electro-Chromic/Thermal Devices With Excellent Durability For Applications In Smart Electronics.

Kartik Nemani, Department of Mechanical Engineering,
University of Toledo, USA

Hossein Sojoudi, Department of Mechanical Engineering,
University of Toledo, USA

Abstract

Thin-film electro-thermal/chromic devices were fabricated by utilizing PEDOT:PSS as the active conductive electrode thin-film and a compliant flexible polyurethane/ glass substrate as the building block. PEDOT:PSS exhibits electrochromic properties by undergoing an electrochemical redox reaction when an external stimulus in the form of electric potential is induced across the film. One major advantage of this technology is that it requires significantly lesser power per unit area and the color switching can be bi-stable in either transparent (oxidation) or dark blue (reduction) states. This low powered, controlled tuning in transparency of PEDOT:PSS was achieved by coupling doped PEDOT:PSS films with graphene as counter electrode, sandwiched between a solid-state electrolytic medium while maintaining high level of transparencies ~85% at peak oxidation levels. A high color contrast and improved coloration efficiency of 75% coupled with low power densities of 0.96 W/m^2, envisions its used in smart windows and visors. The mechanical self-assembly approach of graphene can be regulated by controlling the wavelength of wrinkles generated by inducing measured pre-strain conditions and regulating the modulus contrast of the materials used, which control the level of transparency, conductivity, and hydrophobic nature of the electrode(s). The transparency of wrinkled few layered graphene with an induced biaxial pre-strain ε_{pre} = 0.36 was found to be 95% at 550 nm.

We have also harnessed the electrothermal nature of PEDOT:PSS to achieve significant thermal responses at the expense of low power inputs to achieve temperatures as high as ~100°C due to joule heating in the doped PEDOT:PSS thin films. The absorbance and transmittance spectra for PEDOT:PSS were studied using a UV-VIS spectrometer at various oxidation and reduction states by applying biased voltage in the range of 2-5 Volts in varying cycles to determine electrochromic/thermal reversibility under induced strains, and electrothermal nature at various additive concentrations. These exceptional properties of the polymer, coupled with high work-function graphene electrodes can be envisioned to develop in-tandem smart electronic windows with tunable transmittances and heating responses for applications in automobile, aerospace, and service industries.

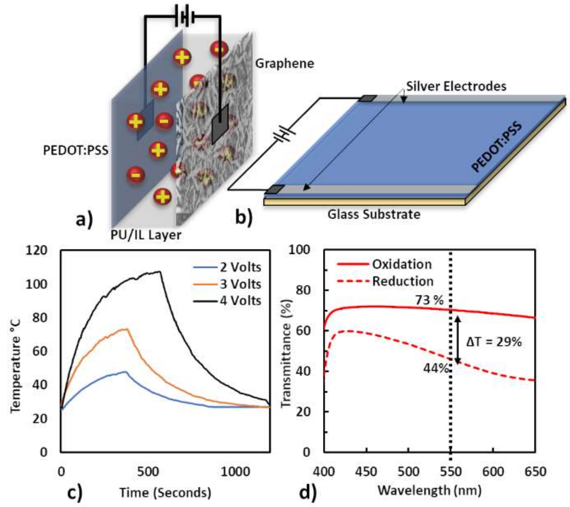

Figure: (a) Schematic of an Electrochromic device with graphene, PEDOT:PSS and Polyurethane/Ionic-Liquid solid-state electrolytic medium, (b) A PEDOT:PSS based electrothermal device (c) Temperature vs time plot exhibiting fast electrothermal response of thin-film, (d) Transmittance plot for an electrochromic device exhibiting transmittance ratio (ΔT) ~29 % at peak oxidation and reduction states.

Recent Publications

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Biography

Kartik Nemani is a Graduate student in the Department of Mechanical, Industrial, and Manufacturing Engineering at the University of Toledo. He earned his Bachelors in Mechanical Engineering from the Jawaharlal Nehru Technological University-India. Prior coming to the U.S, he worked as a Research Associate at the Indian Institute of Technology-Guwahati. He is currently working on graphene and flexible electrochromic/electrothermal devices. **Email: srinivasakartik.nemani@utoledo.edu**

Biography

Hossein Sojoudi is an Assistant Professor in the Department of Mechanical, Industrial, and Manufacturing Engineering at the University of Toledo. Prior to joining UT, he was a Postdoctoral Associate and Lecturer in the Mechanical Engineering Department at MIT with a joint appointment in the Chemical Engineering Department. He received several awards including the prestigious Ann Robinson Clough Grant from Georgia Tech, and several others from MIT. Hossein has authored more than 30 papers published in Science, Science Advances, Advanced Energy Materials, Advanced Functional Materials, and other with over 1995 citations. **Email: hossein.sojoudi@utoledo.edu**