Carboxylic acid functionalized multiwalled carbon nanotube-alkane based resistive thermal switch for electrochromic indicator.

Abstract

Discovery of carbon nanomaterials, particularly carbon nanotubes (CNT), have revolutionized the field of electro-chemical sensors, owing to their unique electrical properties. They exhibit a wide range of surface modification reactions and remain stable at room temperature and pressure. Hence, they can be used as nanofillers in polymer or solvent matrix for sensor applications. Consequently, an ideal temperature sensor can be built by choosing a matrix with desired phase transition temperature and compatible nanofiller (chemically modified CNT).

In this work, we have investigated the use of COOH-functionalized MWCNT-hexadecane dispersions with 1-hexadecanol as stabilizing agent for temperature sensitive electronic sensor. On cooling, pure hexadecane has a phase transition from liquid to solid around 18 ºC temperature. Thus, a switching in resistance state of the dispersion is observed in the cooling cycle. Here, we have achieved a **switching ratio (R_{OFF}/R_{ON}) of approximately ~10^3 order** for a PET-ITO electrode-based device with dimensions (1cm × 0.5 cm× 0.220 mm). The OFF state corresponds to a well dispersed phase of MWCNT-COOH in hexadecane above 15 ºC. In OFF state, there is no overlap of nanotubes giving rise to a highly resistive path for the electrons. But, as the temperature drops below 12 ºC, the crystallization of hexadecane leads to phase separation MWCNT-COOH tubes, resulting in the creation of conductive pathways through overlap (ON state). Further, a descending temperature sensor prototype was fabricated by employing an electrochromic indicator and a supercapacitor module (3.5 volt) in a series circuit. As prepared smart label successfully displayed the information through color change when the temperature drops below a threshold.

KEYWORDS: MWCNT-COOH (multi-walled carbon nanotubes functionalized with carboxylic acid group), hexadecane, phase transition, PET-ITO (indium tin oxide coated polyethylene terephthalate electrode), descending temperature sensor.

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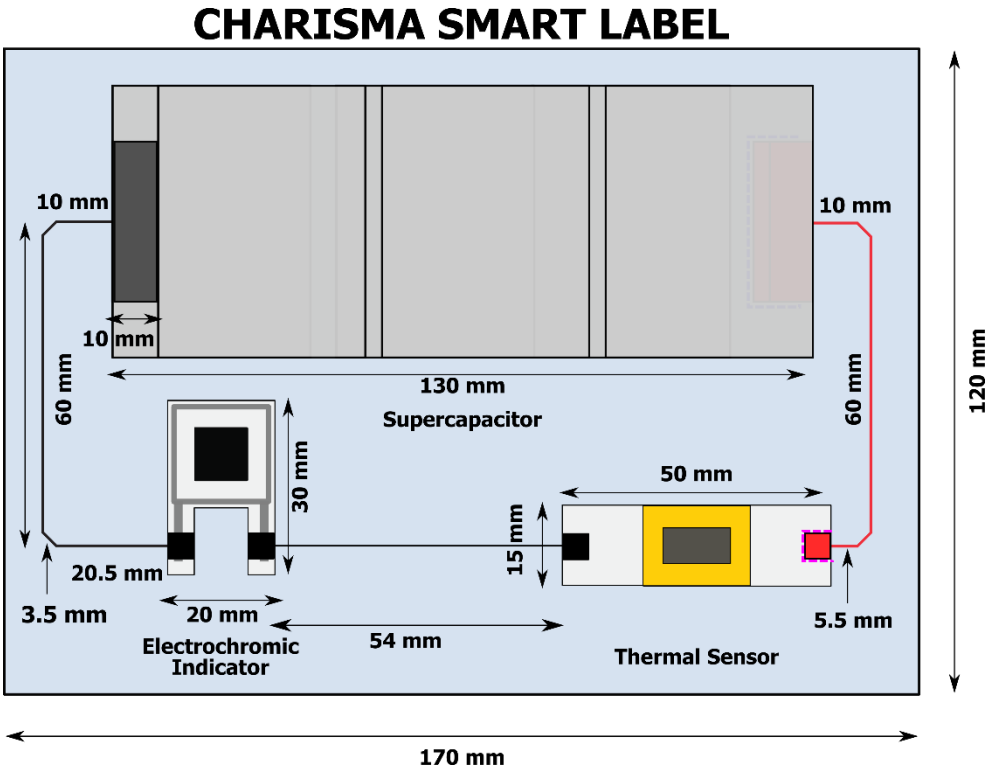

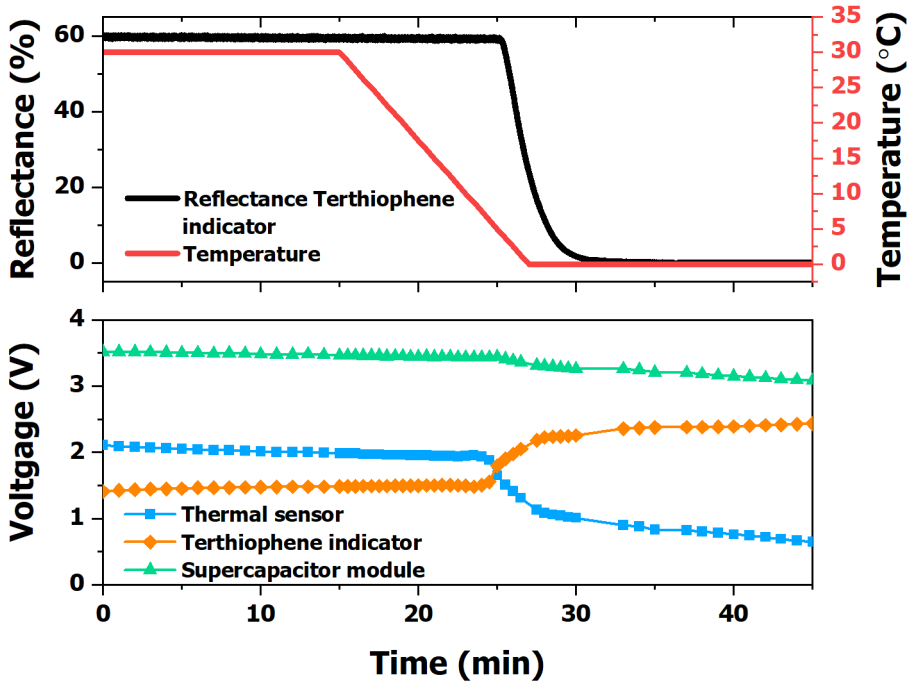

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