PEDOT and graphene based electrodes printed by screen-printing on plastic and paper and application on flexible electrochromic devices

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The present work describes the deposition of PEDOT and graphene based films on plastic and paper using screen-printing. Electrochromic devices (ECDs) were assembled using these PEDOT/graphene based electrodes.

Over the last years, the use of transparent conductive electrodes (TCE) has been growing for many different applications in areas such as portable electronics, displays and flexible electronics; a few examples are multi-functional windows, touchscreens, solar cells, transistors and electrochromic devices (ECD). Lately, the integration of ECDs in disposable applications has gained a growing interest in the printed electronics field.

The most commonly used TCE is indium-tin oxide (ITO), which, in most cases, is used as a thin film sputtered onto glass or plastic. However, this material has several limitations and possible alternatives are being extensively studied.

PEDOT is a conductive polymer with a strong blue coloration and is used both as a conductive material, as well as an electrochromic material. Doping PEDOT with carbon-based materials results in films with higher transparency, as well as higher conductivity, which still maintain the electrochromic functionality of PEDOT and its electrochemical reversibility. The main objective of this work is to print a single layer of PEDOT/graphene formulations that acts as electrode and electrochromic material simultaneously when assembled in electrochromic devices (thereby reducing the conventional 5 layer device to a 3 layer device). The hybrid PEDOT/graphene formulation can also be used to print transparent electrodes for other devices that do not involve redox reactions.

Several PEDOT/graphene formulations were prepared and printed. The resulting thin films were characterized in terms of electrical and optical properties, as well as stability measurements. Techniques such as cyclic voltammetry, UV-Vis spectroscopy, SEM and mechanical tests (tape peeling test, scratch test and bending test) were used. The performance of the resulting devices was compared with that of conventional ones (5 layer structure) through the analysis of the device color contrast over time during continuous operation conditions using a cycling program.