Electrochromic properties of electrodeposited PEDOT/GO films on flexible substrates

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Introduction

Electrochromic materials have been extensively researched for applying in smart displays, energy-saving windows, electronic papers and military camouflage due to ample color change, high coloration efficiency, low driving voltage, low energy consumption and memory effect under open circuit condition. Lightweight, thinner, comfortable to use and, therefore, preferable are electronic devices made on flexible substrates. In contrast to inorganic semiconductors, conjugated polymers have the advantages of multicolor changes, faster switching speed, better coloration efficiency, easy design and cost effectiveness for large area and light weight electronic devices. Among them, poly(3,4-ethylenedioxythiophene) (PEDOT) has been widely used due to switching the color fast from deep-blue to pale-blue, large conductivity, high transmissivity for visible radiation, low band gap, environmental and electrochemical stability [1-3].

Aims

To study the conditions of electrochemical obtaining and properties of PEDOT/GO functional thin films on flexible PET/ITO electrodes, to research the influence of the electric field on it's optical absorption spectra.

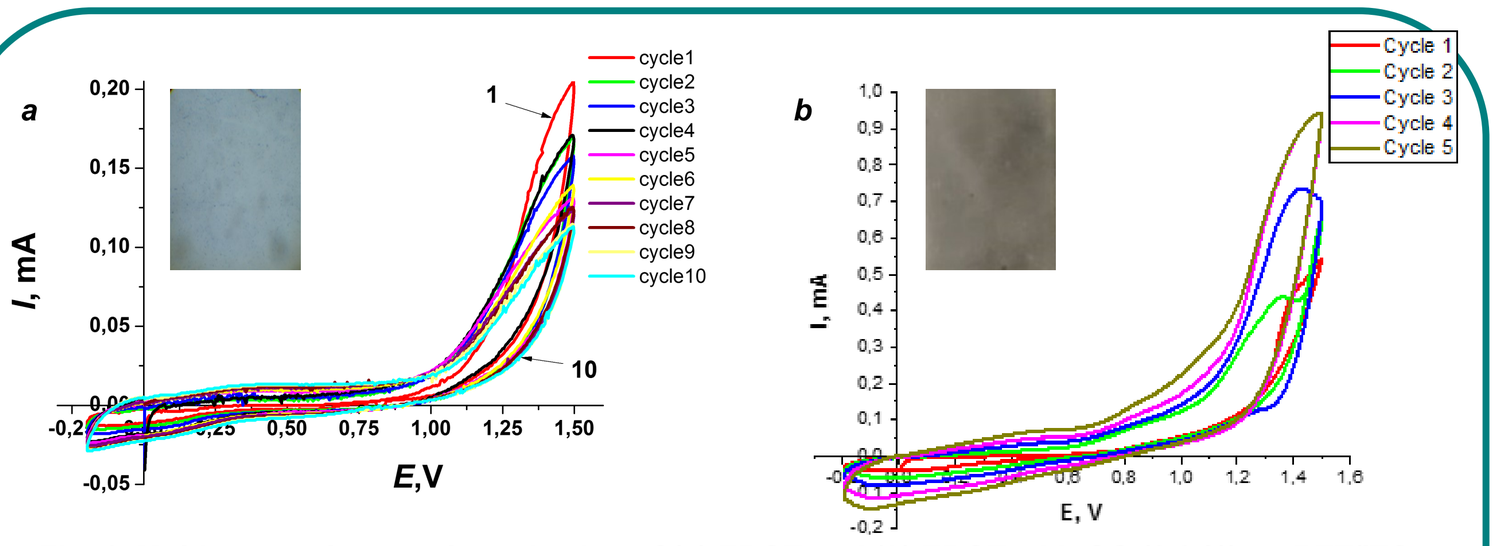

Fig. 1. Multisweep electropolymerization of (*a*) EDOT and (*b*) EDOT with GO (0.3 %) on PET/ITO in mixed solvent at scan rate of 20 mV×s^{-1}

It is shown that for EDOT a gradual decrease in currents of electrooxidation maxima with increasing number of sweep cycles is observed, whereas in the presence of GO there is a shift of potentials of electrooxidation maximum by 0.2-0.3 V in the anode region and an increase in currents after the second cycle due to the formation of electroactive high-conductivity polymer layer with a developed surface.

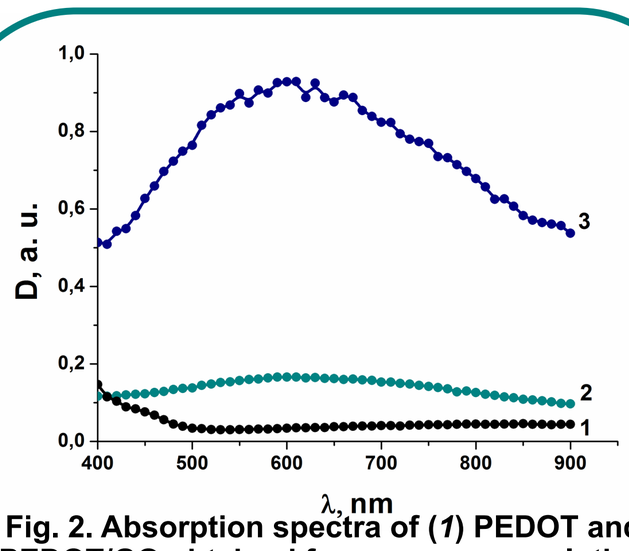

Fig. 2. Absorption spectra of (*1*) PEDOT and PEDOT/GO obtained from monomer solution with addition of GO dispersion, vol%: 0.2 (*2*); 0.3 (*3*)

The absorption spectra of PEDOT-GO films show a wide intense band at λ = 570–820 nm, which corresponds to the absorption of free charge carriers in the polaron-bipolaron zone. The optical density at the maximum reaches values to D = 0.9-0.95 (0.3 % GO), which significantly exceeds the values for obtained PEDOT films on PET/ITO.

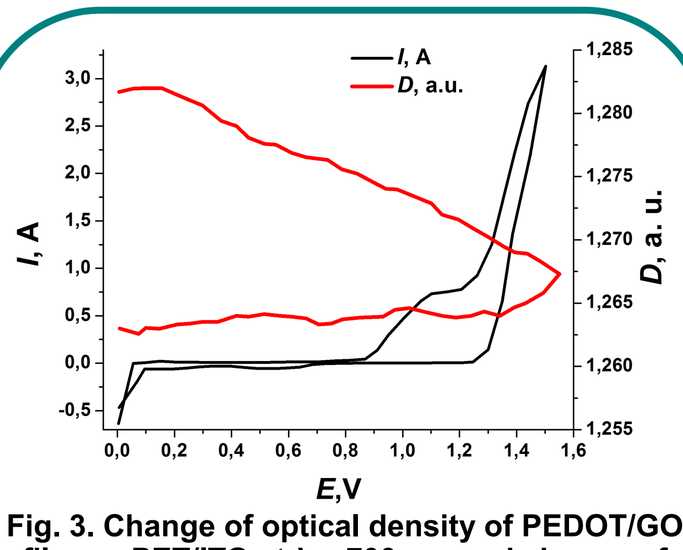

Fig. 3. Change of optical density of PEDOT/GO film on PET/ITO at λ = 700 nm and change of potential from 0 to 1.5 V (relative to Pt) at scan rate of 10 mV×s^{-1}

It was found that at λ = 700 nm the optical density significantly depends on both the direction of the potential scan and the value of the potential. The largest change in optical density is observed at the anode part of the CVA curve. A sharp change in the optical density occurs when the applied potential approaches zero and the PEDOT is in a partially reduced form.

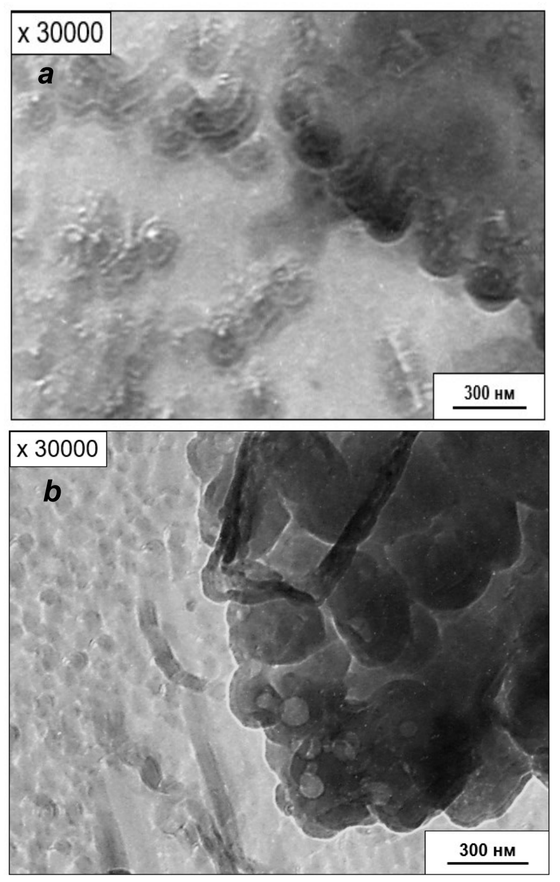

Fig. 4. TEM images of (*a*) PEDOT and (*b*) PEDOT/GO

It has been found that modification of PEDOT with GO leads to increasing of globule sizes to 200–250 nm and formation of layered structure with graphene plates, which will greatly increase its specific surface area and, therefore improved the functional properties.

Conclusion

It is established that the composite films of PEDOT/GO obtained on flexible PET/ITO surfaces show electrochromic properties. The proposed method of modifying the structure and properties of functional polymer layers with graphene oxide can be used to develop new elements of optical devices of organic electronics.

Acknowledgements

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References

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