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Influence of noble metal nanoparticles on near-electrode processes at interface of ITO-cadmium octanoate

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In the frequency range from 50Hz to 5MHz of the electric current, the influence of Au and Ag nanoparticles in cadmium octanoate composites on the frequency dependence of the complex permittivity ε' and ε'' was studied. The metal nanoparticles (4 mol %) were chemical synthesized in thermotropic smectic liquid-crystalline phase of cadmium octanoate in the temperature range from 100°C to 150°C. Anisotropic glassy nanocomposites are obtained by cooling of the nanocomposite mesophase to the room temperature. The thickness of the nanocomposites samples was 50 μ. Measurement of dielectric properties was carried out using high-precision equipment Hioki 3532-50 LCR and Keithley 2636B in the temperature range from 22°C to 150°C.

It is shown that for low frequencies less than 10^3Hz, especially at temperatures corresponding to the transition of the nanocomposites to the smectic phase, a dispersion of ε' and ε'' is observed. An essential fact of such a dispersion is sufficiently large values of ε' and ε''. It is shown that the reason for such large values of the components of the complex dielectric constant is the redistribution of

the electric field in the sample in such a way that a considerable part of the voltage is applied to a thin (on the order of nanometers) near the electrode layer. It was found that the dielectric relaxation due to the near-electrode processes can be described by the Cole-Cole dispersion:

$$\frac{\varepsilon_s - \varepsilon_\infty}{\varepsilon^* - \varepsilon_\infty} = 1 + (i\omega\tau)^{1-\alpha}$$

Where ε^* - is the complex permittivity, ε_s and ε are the permittivity at frequencies f, respectively $f = 0$ and $f =$, $= 2 f$ - is the cyclic frequency, - is the relaxation time, and - the Cole-Cole parameter (according to the theory of relaxation processes, its value varies from 0 to 1).

It is shown that the introduction of noble metals nanoparticles does not lead to a change in the value of the Cole-Cole parameter, but leads to a substantial (by more than an order of magnitude) decrease in the dielectric relaxation time. It was found that with the same concentration of nanoparticles in cadmium octanoate (4 mol %), the effect of Au nanoparticles is more significant than for Ag nanoparticles. Possible mechanisms for such a difference are discussed.