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"The phase transfer process of gold nanoparticles for their implementation as an ink components used for hybrid organic/inorganic electronic systems preparation"

Recently, one of the key research area on nanoparticles (NPs) is their usage as a building blocks for flexible electronics production. Hybrid memory structures, which consist of organic and inorganic materials, are promising candidates for electronic systems preparation in modern information storage technologies such as non-volatile memory elements (the structure of the device is shown in Figure 1). The systems contain metal NP in polymer matrix demonstrate the memory effect due to resistive switching mechanism. Such devices can be produced by printing or spin-coating techniques on the flexible, transparent substrates that is an advantage compare to the traditional electronics. However, work with these systems requires the use of organic solvents, because water can destroy the surface structure of memory devices components.

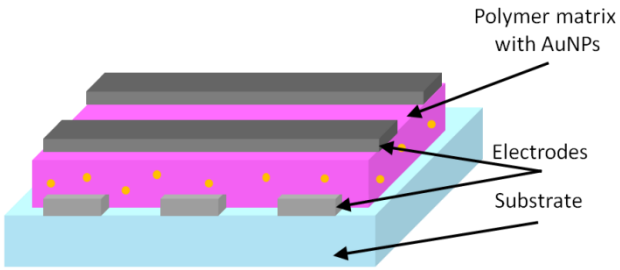

Figure 1. Scheme of the structure of hybrid organic/inorganic memory device.

The main issue undertaken in this work is development of the procedure which allow to obtain stable and monodisperse organic colloids of gold nanoparticles (AuNPs) and their incorporation into selected polymer matrix for the inks composition used e.g. hybrid organic/inorganic memory devices construction. In this work, the effective and efficient procedure to obtain stable and monodisperse organic colloids of AuNPs by the phase transfer method is described. Additionally, the procedure of the inks based on the polymer solutions contain modified AuNPs was developed. Based on the experimental work the analysis of the AuNPs modifier structure on their distribution in polystyrene matrix was performed.

To obtain the organic colloids of AuNPs the phase transfer method of water based colloids was used. The main idea of the phase transfer method is exchange of the AuNPs surface modifiers: from hydrophilic stabilizers in the water to hydrophobic, ensure their dispersion in organic media. The phase transfer method allow to use a monodisperse, narrow size distributed nanoparticles. An additional advantage is the possibility of receiving NPs directly in the solvent constituting component of the inks. For the phase transfer of AuNPs the aliphatic and aromatic

thiols, n-dialkyldithiophosphates and amines were used. Conducted research allowed for the selection from modifiers, those which provide stability in organic solvents (toluene and anisole). Additionally the influence of the structure and concentration of modifier, type and physicochemical properties of organic media on the efficiency of the phase transfer and stability of obtained organic colloids of AuNPs was investigated.

The organic colloids of AuNPs prepared by the phase transfer method were used for the inks based on toluene or anisole and polymer (polystyrene, poly(methyl metacrylate)) composition. For this purpose the modified solution method was used. Another important issue undertaken in this study was development and optimization of the thin films of the polymers with AuNPs production for electron microscopy characterization. Application of the developed procedure allowed the qualitative characteristics of AuNPs in the polymer matrix. Based on the experimental work the analysis of the AuNPs modifier structure on their distribution in polystyrene matrix was performed. It was found that the chemical compatibility of AuNPs surface modifiers and polymer structure has significant impact on nanoparticles distribution in the matrix.

The prepared inks were used in the hybrid memory devices construction. The analysis of the current – voltage (I-V) characteristic of obtained systems allowed to conclude that the resistive switching mechanism shows the memories which contain AuNPs in polymer matrix. It was found that for tested systems the presence on AuNPs in polymer matrix is essential for their proper functionalization.

In conclusion, the results of experimental work led to develop and optimized the effective procedure of organic colloids of AuNPs preparation and their incorporation into polymer matrix. The produced systems can be used as inks for hybrid memory devices construction and in other application require organic colloids of NPs or inks.