The Mechanism of Resistance Switching in Films Based on Partially Fluorinated Graphene.

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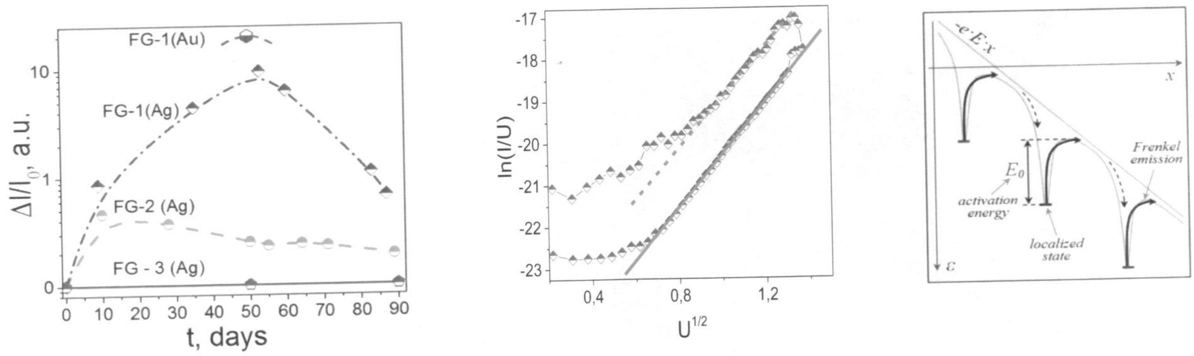
Recently a wide range of materials are used for the fabricating of memristors. Structures based on graphene oxide (GO) showing resistive switching represent the great interest, but these memristor devices were found to exhibit unstable resistive effect. Fluorographen (FG) is more stable derivative of graphene, and partially fluorinated graphene with variable properties is considered as a promising material for fabricating of memristors [1]. It is known that resistive switching is observed in two-phase systems. Hence, it is necessary, that fluorinated graphene to contain a second phase providing resistive switching.

Original procedure for preparing fluorinated graphene in aqueous hydrofluoric acid solution has been developed in our laboratory [2]. In this report we have investigated the resistive switching effect in the composite films of fluorinated graphene with dimethylformamide (DMF) – FG-1, N-methylpyrrolidone (NMP) – FG-2 and without organic additives – FG-3 used at the stage of graphene suspension creation. DMF is an active compound forming a functional groups. DMF and water chemically react to form formate, that is functional group with a low activation energy. NMP is stable compound, which does not form functional groups in an aqueous medium. It was found, that if suspension of fluorographene not contained any organic additives, (Fig.1*a*), the resistive switching is not observed in fabricated films. Structures based on suspension with NMP exhibit resistive relatively weak switching effect (less than 0,4 a.u.), while adding DMF in suspension leads to change in resistance of films in 10 – 20 times.

Thus, the strongest resistive effect is observed for fluorographene films with functional groups of dimethylformamide (Fig.1*a*). The current-voltage characteristics of these samples have been studied on the mechanism responsible for the current in the structure. As it turned out, the current-voltage dependence is described the mechanism of Frenkel-Poole, linear regions are observed in the coordinate of ln(I/U) depending on the $U^{1/2}$ (Fig.1*b*) with trap activation energy of 80 meV. A schematic representation of the Frenkel-Poole conduction mechanism shown in Fig.1*c*.



a) *b)* *c)*

Fig.1: a) Dependences of the relative change in current as a function of fluorination time for suspension with different organic additives (NMP and DMF) and without one, the contact material to the film are indicated in brackets, b) Current - voltage characteristics for FG-1 structure in the coordinate axes ln(I/U) depending on the U1/2, c) a schematic representation of the Frenkel-Poole conduction mechanism.

The influence of different organic additives on the resistive switching effect in films of fluorinated graphene, origin of this effect and current flow mechanism are discussed in this report. The presence of substance traces affects on the formation of conductive paths in partially fluorinated graphene films, chemical functional groups to form a conductive phase in two-phase systems. Stability of resistive switching is provided by capsulation of organic functional groups by fluorinated graphene flakes.

This study was partially financed by the Russian Science Foundation (grant No. 15-12-00008).

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