ELECTRICAL PROPERTIES OF A HYDRATED CONTACT OF DIFFERENT-SIZED YSZ –PARTICLES

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Nanopowders based on dioxide of zirconium are of interest for practical application due to dimensional effects caused by the specific state of electronic subsystem of nanoscale objects. For example, the effect of electric charge accumulation by a compact of zirconium dioxide nanoparticles [1,2], the effects of adsorption-induced electrical conductivity [3], and many more, indicate interphase electronic exchange. It has been established that adsorption changes the electronic structure and physical properties of the nanoparticle material, in particular, imposes a spectrum of local levels of adsorbates on the energy spectrum of states with non-adsorption origin (surface states of the impurity type), which leads to interesting and extremely important effects.

The dimensional effects that occur at the contact of hydrated nanopowder of ZrO_2 –Y_2O_3 (YSZ) - systems are extremely interesting due to their possible application .

In this work, the contact of nanoparticles with the same chemical composition (ZrO_2 – x mol % Y_2O_3, x=0; 3; 8) but different sizes (7.5 and 10 nm) were studied by voltammetry at different relative humidity condition (85%, 75%, and 60% of humidity).

The nonlinear dependence of their electrical properties on direct current was established: (V-I characteristic, Fig.1).

As can be seen from Fig.1, for all humidity concentrations in the samples, there is a clear dependence of the current amplitude on the impurity concentration. The syste without alloying component undergoes minimal changes in the electrical field (less than 5-10% of the equivalent value for systems with 3 and 8 mol % Y_2O_3). Impurity conentrations over 3%mol leads to a decrease in the amplitude of the current with an increase in the voltage modulus on the electrodes. It can be seen that the value of the limiting current (direct branch V-I reaches its maximum value at 85% of humidity (Fig.1a) at a concentration of 3 mol % Y_2O_3 and then decreases with increasing impurity concentration. At the hydration degree of the system is 75% the maximum current value is shown by the system with 8 mol% Y_2O_3 (Fig.1b). Thus, the concentration of humidity vapor corresponding to 85% and with 3 mol% of the impurite concentration (Fig.1a) ensures that the system reaches the maximum limit parameters both on the direct and reverse branches of the voltage curve.

As can be seen from Fig.1c, a decrease in the humidity concentration in the system leads to a decrease in the level of electrical characteristics of the contact, describing its rectifying properties. In particular, both the level of limiting characteristics and the nature of dependencies are reduced, for instance, the contact passes from the state of the rectifying contact with the most pronounced asymmetry to the state of the so-called "false connection".

A general pattern has been established for the studied systems, consisting in the dependence of the nature of the electrical properties on the humidity concentration in the samples. In particular, it was found that at a low humidity concentration (saturation in a humid atmosphere at 60% relative humidity (an insular layer of water molecules on the surface of nanoparticles), a "false connection" type of contact takes place. As the relative humidity of the atmosphere in which the system was saturated increases to 85% (free water in the pores), the nature of the contact changes to semiconductor, which indicates the significant role of the nature and dimension of electrical conductivity in the formation of semiconductor properties of the contact.

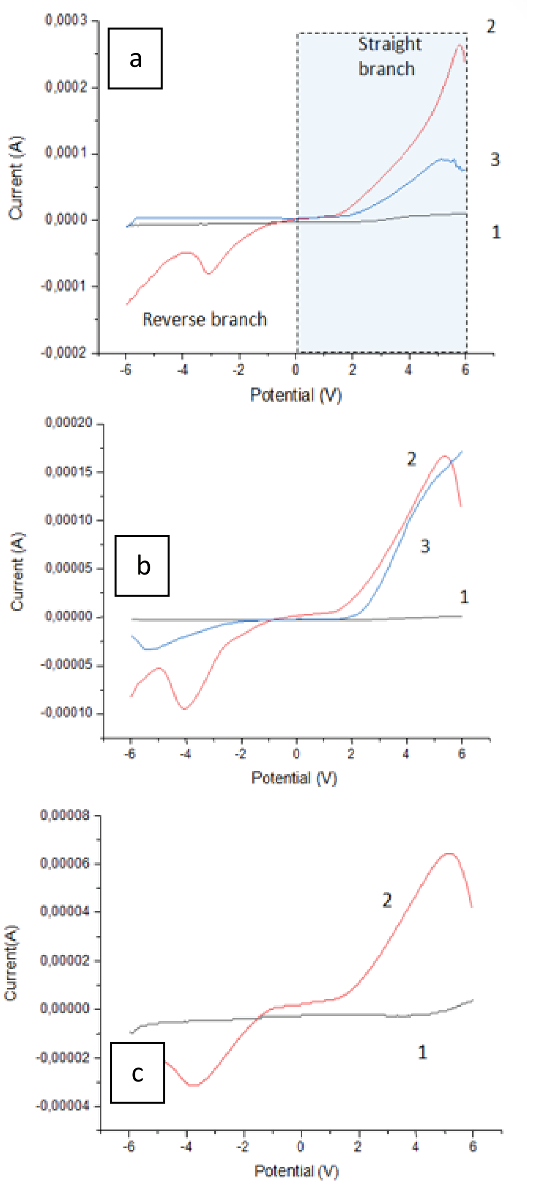

Fig.1. The group of VAC heterojunctions obtained at 85% (a), 75% (b) and 60% (c) humidity at the contacts of samples of the composition ZrO_2 – 0 mol% Y_2O_3,(1), ZrO_2 – 3 mol% Y_2O_3 (2) and ZrO_2

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