Physical phenomena in a nanopowder system based on zirconia caused by an external electric field

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The aim of this work is to elucidate the possibility of using of concentrated dispersed system consisting from nanoparticles of composition ZrO_2-3mol% Y_2O_3 as nanoionic storage device of electric energy. The electrical and adsorption properties of zirconia nanoparticles in a consolidated state were studied for this.

The effect of accumulation of electric charge by sealed (using high pressure) nanoparticles of zirconia with density of capacity up to 100 μF / g after exposure in an electric field (100 ÷ 10000 V / m) at a temperature of 300 K was revealed. The effect has a dimensional nature. The dependences of accumulated voltage and discharge rate from size of nanoparticles, sealing pressure and charging voltage were studied. Using the method of impedance spectroscopy, the electrical properties of established effect were studied.

It is shown that the mechanism of the phenomenon is caused by a chemical interaction of surface of oxide nanoparticle with an adsorption ionic atmosphere. Electric charge layer that formed in the near-surface zone of a material of nanoparticles with an opposite charged adsorption layer that localized on the surface of nanoparticles are formed an electric capacitance. Recharge in the electric field of located on both sides of surface of unlike charge layers leads to accumulation of energy.

The established effect opens the possibility of creating of solid state capacitors of high density of capacity, which in terms of performance characteristics will significantly exceed basic analogues of planar design. Temperature stability of dielectric material widens the operating temperature range of such device. One of the important advantages of this development is the possibility of reducing size of a device to microscopic dimension.