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Theory of fast ion transport on nanoscale and computer exploration

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Abstract content
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The future integrated circuits in deep sub-voltage nanoelectronics [1] should include devices with fast ion transport (FIT). Among them, all solid state thin-film impulse supercapacitors which basic working part is a solid electrolyte (SE)/electronic conductor (EC) heterojunction. It implies the development of the FIT-theory on nanoscale. However, until now the basic FIT-theory describing nano-object response on external dynamic influence is absent. For the problem decision, for development of nanoionics [2] and interpretation of frequency-dependent impedance of SE-nanosystems we have put forward structure-dynamic approach (SDA) of nanoionics [3]. Theoretical system of SDA includes a structural layered 1D-hopping atomic model of the region with a non-uniform potential landscape, a method of "hidden" variables (excess concentrations of mobile ions induced by external influence on crystallographic planes), a physico-mathematical formalism (based on the principle of a detailed balance and the kinetic equation in the form of the particle conservation law), and a method of uniform effective field. A new notion - the Maxwell displacement current on a potential barrier and the essential definition of effective electrostatic field (corrected uniform Gauss field) [4,5] are given. The computer exploration of the ion-transport and dielectric-polarization processes of model SE/EC heterojunctions are analyzed, and such modes of solid state ionics as "near constant loss" and Johnsher's universal dynamic response (the power law of the real part of frequency dependent conductivity) are explained.

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