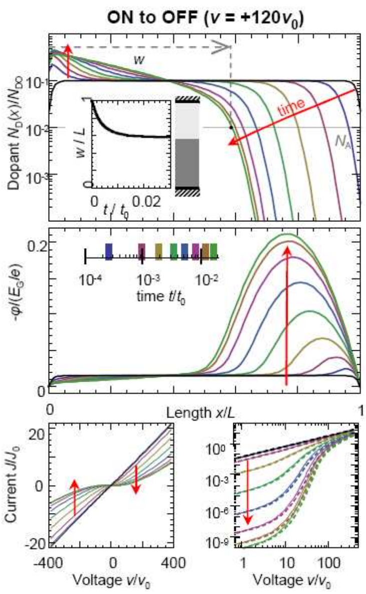
COUPLED IONIC AND ELECTRONIC TRANSPORT MODEL OF THIN-FILM SEMICONDUCTOR NANODEVICES

Dmitri B. Strukov

Electrical and Computer Engineering, UC Santa Barbara, Santa Barbara, CA 93106

We provide a physical model for resistance switching effect in thin film devices based on numerical solutions of drift-diffusion equations for electrons, holes and ions coupled by Poisson equation with appropriate boundary conditions [1]. The model is quite general and can be applied to materials that act as solid-state electrolytes, e.g., nonstochiometric compounds with mobile defects such as oxygen vacancies. We simulate the dynamics of a two-terminal device based on a semiconductor thin film with mobile dopants that are partially compensated by a small amount of immobile acceptors. We examine the mobile ion distributions, zero-bias potentials, and current-voltage characteristics of the model for both steady-state bias conditions and for dynamical switching to obtain physical insight into the transport processes responsible for memristive behavior in semiconductor films. We will then briefly discuss applications of such thin film devices for super dense memories, high performance programmable logic devices and artificial neuromorphic networks [2].



Dynamical resistance states for a fixed voltage (positive or negative) applied to the right-hand electrode ($x = L$) examined after different time intervals: mobile ion concentrations, zero field electrical potentials,and the corresponding *i*-*v* plots shown in with linear and logarithmic scales, respectively.

References

[1] D.B. Strukov, J.L. Borghetti, R.S. Williams, Coupled ionic and electronic transport model of thin-film semiconductor memristive behavior, Small, vol. 5 (9), pp. 1058-1063, 2009.
[2] K.K. Likharev and D.B. Strukov, CMOL: Devices, circuits, and architectures, in Introducing Molecular Electronics, G. Cuniberti, G. Fargas, and K. Richter, Eds. Berlin: Springer, pp. 447-478 (2005)