IOPscience

This site uses cookies. By continuing to use this site you agree to our use of cookies. To find out more, see our Privacy and Cookies policy.

PAPER • OPEN ACCESS

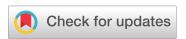
Surface trap mediated electronic transport in biofunctionalized silicon nanowires

F Puppo^{1,3}, F L Traversa², M Di Ventra², G De Micheli¹ and S Carrara¹ Published 15 July 2016 • © 2016 IOP Publishing Ltd Nanotechnology, Volume 27, Number 34

francesca.puppo@epfl.ch ftraversa@physics.ucsd.edu diventra@physics.ucsd.edu giovanni.demicheli@epfl.ch sandro.carrara@epfl.ch

- ¹ Integrated Systems Laboratory, École Polytechnique Fédérale de Lausanne, Lausanne 1015, Switzerland
- ² Department of Physics, University of California, San Diego, La Jolla, CA 92093, USA
- ³ Author to whom any correspondence should be addressed.

Received 8 March 2016 Accepted 7 June 2016 Published 15 July 2016



Method: Single-blind

Revisions: 2

Screened for originality? Yes

F Puppo et al 2016 Nanotechnology 27 345503

https://doi.org/10.1088/0957-4484/27/34/345503

Abstract

Silicon nanowires (SiNWs), fabricated via a top-down approach and then functionalized with biological probes, are used for electrically-based sensing of breast tumor markers. The SiNWs, featuring memristive-like behavior in bare conditions, show, in the presence of biomarkers, modified hysteresis and, more importantly, a voltage memory component, namely a voltage gap. The voltage gap is demonstrated to be a novel and powerful parameter of detection thanks to its high-resolution dependence on charges in proximity of the wire. This unique approach of sensing has never been studied and adopted before. Here, we propose a physical model of the surface electronic transport in Schottky barrier SiNW biosensors, aiming at reproducing and understanding the voltage gap based behavior. The implemented model describes well the experimental I–V characteristics of the device. It also links the modification of the voltage gap to the changing concentration of antigens by showing the decrease of this parameter in response to increasing concentrations of the molecules that are detected with femtomolar resolution in real human samples. Both experiments and simulations highlight the predominant role of the dynamic recombination of the nanowire surface states, with the incoming external charges from bio-species, in the appearance and modification of the voltage gap. Finally, thanks to its compactness, and strict correlation with the physics of the nanodevice, this model can be used to describe and predict the I-V characteristics in other nanostructured devices, for different than antibody-based sensing as well as electronic applications.

Export citation and abstract



RIS



Original content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

3. Model	
4. Results a	nd discussion
5. Conclusion	ons
Acknowledg	gments
References	
0:1-1:	
Citations	
Related cont	
Related cont	
Related cont JOURNAL ARTIC One-dimension review	LES
Related cont JOURNAL ARTIC One-dimension review Silicon and gen transistors	LES nal Si/Ge nanowires and their heterostructures for multifunctional applications—a
Related cont JOURNAL ARTIC One-dimension review Silicon and gentransistors Tunable Schot	hal Si/Ge nanowires and their heterostructures for multifunctional applications—a rmanium nanowire electronics: physics of conventional and unconventional
Related cont JOURNAL ARTIC One-dimension review Silicon and gentransistors Tunable Schot Origin of noise	hal Si/Ge nanowires and their heterostructures for multifunctional applications—a rmanium nanowire electronics: physics of conventional and unconventional tky barrier and high responsivity in graphene/Si-nanotip optoelectronic device

+ 2. Experiments