nanoelectronic materials laboratory

Press Release

World´s first universal transistor, fusing n- and p- type behavior with equal performance into a single device.

NaMLab achieved a significant breakthrough in developing reconfigurable nanoelectronic circuits

Dresden, August 15, 2013– Scientists at the *Nanoelectronic Materials Laboratory* (NaMLab gGmbH) have demonstrated the world´s first universal transistor that delivers equal performance for n- and p- type response. They demonstrated an energy efficient CMOS circuit with one single transistor type instead of the two different types used in conventional electronics. Additionally, the nanowire circuit provides different circuit functions enabled by switching the transistors configuration. State of the art devices have significantly differences in composition, technology and size for the different conduction types. The new technology could change the current major CMOS technology significantly enabling a single MOS technology with enhanced functionality.

The vast majority of today's digital circuits relies on complementary logic (CMOS), where p- and n- type transistors are alternately switched to reduce standby-power consumption. For more then 40 years p- and n- type transistors have been designed, scaled and optimized individually in order to achieve equal and therefore compatible electrical performance. For compatibility in circuits the total on-currents, switching slope and magnitude of the threshold voltage have to be equal in p- and n- type transistor. This has been a difficult task, given the different nature of p- and n-type conduction in silicon. For instance, equal on-currents have been achieved by designing the p-transistor significantly wider than the n- transistor. In particular, on-current adjustment in aggressively scaled 3D CMOS transistors where the channel width cannot be freely changed is increasingly difficult.

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The universal transistor developed by NaMLab in cooperation with CfAED solves these disparities by merging the characteristics of p- and n-type transistors into a single device with selective electron and hole injection valves. There the ratio between electron and hole injection is mainly tuned by strain incorporation, realized by a 12 nm thin silicon nanowire embedded in a dioxide shell. In the work of André Heinzig and Walter M. Weber appearing today online in the Journal *Nano Letters,* fully functional silicon nanowire transistors with equal p- and n-type performance and a CMOS circuit built thereof are reported for the first time. In addition, this work shows the first realization of truly complementary reconfigurable circuits enabling the realization of logic functions with fewer transistors, compared to conventional CMOS.

The work was supported by the project ReproNano by the Deutsche Forschungs-gemeinschaft and was carried out in collaboration with the DFG cluster for Excellence Center for Advancing Electronics Dresden (CfAED). NaMLab will discuss the implementation of the results in future products and the required additional R&D work ahead with its industrial partners.

The mentioned publication can be found in the internet at: http://pubs.acs.org/doi/abs/10.1021/nl401826u

About NaMLab

The Nanoelectronic Materials Laboratory gGmbH (NaMLab) was founded in July 2006. It is now a non profit daughter company of the TU Dresden. Labeled as an „An“-Institute of the TU Dresden the company runs on the Campus of the TU Dresden an research laboratory with four labs, a clean room and office area for more than 27 scientists and employees. Material research and development combined with the implementation in nanoelectronic devices are the goal of NaMLabs activites. In addition scientists of NaMLab are engaged in the education of the TU Dresden.

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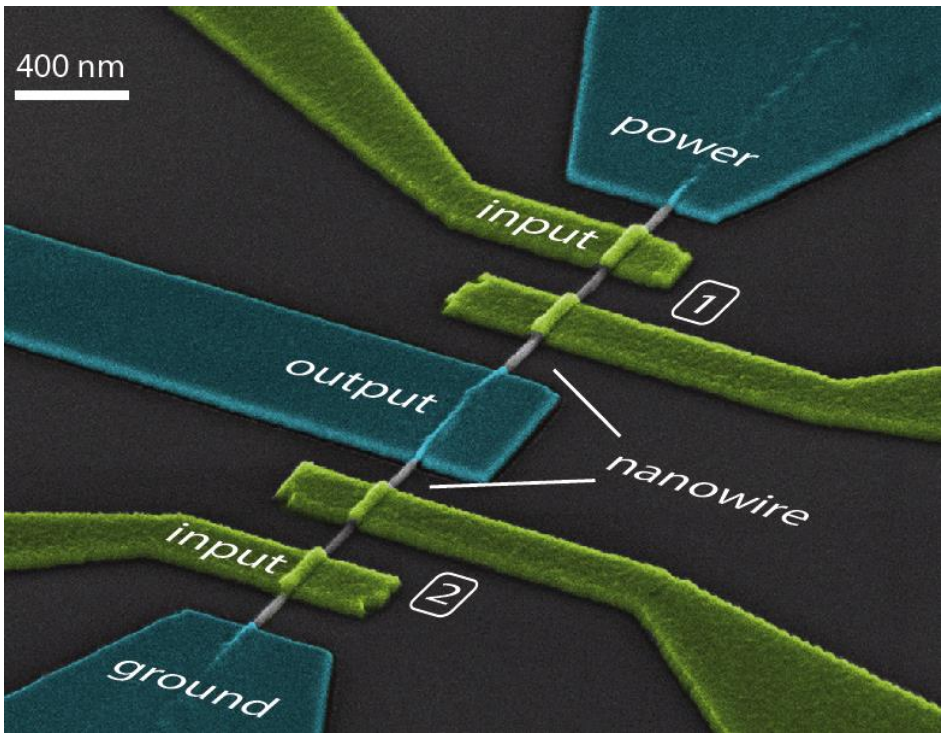

Two universal transistors along a single nanowire configured to create a complementary reconfigurable inverter (colored SEM image)

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