CONTROLLED GROWTH OF CARBON NANOTUBES FOR APPLICATIONS IN MICROELECTRONICS

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The outstanding properties of carbon nanotubes (CNTs) make them interesting for applications in microelectronics. It has been shown that they have outstanding current carrying capacity and thermal conductivity, which makes them potential candidates for interconnects on chips. Moreover, field-effect transistors based on single walled CNTs have been widely demonstrated and outperform silicon-based devices in many aspects. However, for integration into a commercial product the devices have to be manufactured with high yield and reproducibility. Generally, materials created by a bottom-up approach demand new concepts and assembling techniques. So far only a few ideas exist to overcome the integration issues of nano-materials into microelectronics.

The concept of hybrid electronics makes use of the advantages of semiconductor fabrication techniques, such as of lithographic structuring, and therefore allows a parallel processing. The creation of vertical interconnects (VIAS) and vertical transistors (VCNTFET) consisting of CNTs directly on silicon chips can be achieved by Catalytic Chemical Vapour Deposition (CCVD) [1]. For this CNT growth has to be optimised in terms of scaleability, reproducibility, and yield. The crucial point is the catalyst design and its placement on a nanometer scale. Investigations on various catalyst/substrate systems on the growth of CNTs are presented [2]. Interconnects consisting of individual MWCNTs in lithographically defined positions on silicon chips have been synthesized and first electrical characterisations of these CNT-VIAS have been performed.

Secondly, advances in the synthesis of transistors based on SWCNTs are shown. The fabrication of power transistors consisting of multiple, parallel contacted SWCNTs have been achieved with one lithographic step [3]. With this nanotube transistor it is possible to switch macroscopic devices such as a LED or a small motor. The prospects for applications in future microelectronics will be discussed in the light of the outstanding performance of carbon nanotube-based devices and the rapidly developing tools to manufacture CNTs.

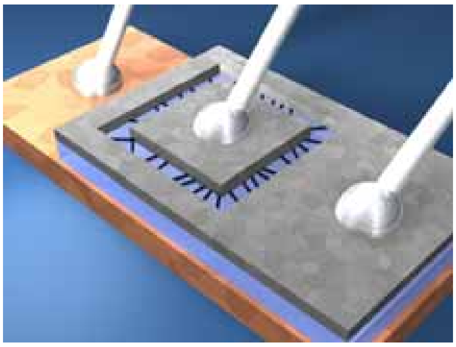

Fig.1: Scheme of a multiple CNT transistor, which is created with only one lithographic step. Such a nano-device is able to switch macroscopic electrical devices**.**

[1] G. S. Duesberg, A. P. Graham, M. Liebau, R. Seidel, E. Unger, F. Kreupl, and W. Hönlein, Diamonds and Related Materials **13,** 354-361 (2004).

[2] R. Seidel, G. S. Duesberg, E. Unger, A. P. Graham, M. Liebau, and F. Kreupl, Journal of Physical Chemistry B **108,** 1888-1893 (2004).

[3] R. Seidel, A. P. Graham, E. Unger, G. S. Duesberg, M. Liebau, W. Steinhoegl, F. Kreupl, W. Hoenlein, and W. Pompe, Nano Letters **4,** 831-834 (2004).