Nanoxerography: Electrostatic Force Directed Printing of Nanomaterials

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Abstract

The first part of this talk reviews recent results in the area of Electric Nanocontact Lithography while the second part will discuss the use of electrostatic forces to direct the assembly of nanomaterials.

First we report on a programmable, reconfigurable, printing approach for parallel nanofabrication of three different types of structures: patterns of charge, oxide, and e-beam sensitive resist. Our approach that we refer to as Electric Nanocontact Lithography (ENL) is based on previous knowledge in the area of conducting scanning probe lithography which uses a conducting probe to electrically expose and modify a surface. ENL makes use of the same physical principles; however, instead of using a single electrical point contact, we use programmable electrical nanocontacts of different size and shape to expose a surface.

In the second part we report on a novel directed self-assembly process to assemble nanoparticle based devices. Nanoparticles are considered potential building blocks for the fabrication of future devices. The use of nanoparticles and nanomaterials in general, however, requires novel assembly concepts. The concept that we present is based on electrostatic interactions. In particular we demonstrate directed self-assembly of nanoparticles onto charged surface areas (receptors) with sub 100 nm resolution. A liquid-phase assembly process where electrostatic forces compete with disordering forces due to ultrasonication has been developed to assemble nanoparticles onto charged based receptors in 10 seconds. A gas-phase assembly process has been developed that uses a transparent particle assembly module to direct and monitor the assembly of nanoparticles. A process is also being developed to enable the patterning of any organic and inorganic nanomaterials with sub 100 nm resolution. First patterns of bio-molecules will be presented. Currently, the electrostatically directed assembly of sub 10 nm sized proteins, 10 – 100 nm sized metal, 40 nm sized silicon nanocubes, and 30 nm – 3000 nm sized carbon nanoparticles has been accomplished. The application to nanoparticle devices will be discussed and first results on a nanoparticle transistor will be presented.

Author Biography

Professor Jacobs received his M.Sc. in Electrical Engineering from the University of Wuppertal, Germany, in 1995, and his doctoral degree (Dr.sc.Techn.) in Engineering from the Swiss Federal Institute of Technology (ETH), Switzerland, in 1999. He joined the faculty at the ECE department at the University of Minnesota in 2001 as an assistant professor after completing postdoctoral research at Harvard University with Professor George M. Whitesides. During his academic career he carried out his research at different departments -- Chemistry (Harvard), Mechanical Engineering (ETH), Physics (ETH), and Electrical Engineering (ETH) -- in interdisciplinary groups, all working in areas of Micro- and Nanotechnology.