How to save Moore´s Law?

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Mooreá law represents the power law relationship between the infomation density and the date of fabrication of micro- and nanodevices. It can also be expressed as an exponential function between the lateral width of micro- and nanostructures and the production date of devices. The slope of the straight line indicates the doubling of the information density or the halving of the lateral width every 18 month, respectively.

At present, semiconductor micro- and nanodevices are fabricated by a classical top-down approach using lithography as intermediate steps and metallization from the vapor phase. The current 256 MBit chip operates with metallic nanostructures of about 200 nm lateral width deposited on semiconductor surfaces, in particular on silicon single crystal surfaces.

It is expected that this commercial silicon technology will be brought to an end in the period between 2008 and 2012 (1). The main reason is that from the present state of view metallic nanostructures of only a few nanometer lateral width cannot be reproducibly fabricated using traditional lithographic techniques. Possible ways to save Moore´s law are to use either patterns of independent X-ray beams or even light of lower wavelength for the etching process. However, these procedures seem to be extremely expensive.

Recently, a different route is considered to save Moore´s law, namely the so-called bottom-up approach. Starting from atoms or molecules being adsorbed on metals, semiconductors, or insulators, defined atomic or molecular structures can be formed by appropriate processes such as adsorption, self-assembling, nucleation and growth, and chemical reactions.

The bottom-up approach allows to fabricate nanostructures with lateral and vertical widths of only a few nanometers, i.e. a small number of atoms or molecules. Such nanostructures are “low-dimensional“ since their electronic behaviour deviates significantly from that of 3D bulk phases (7). For example, electronic quantum-size effects appear even at room temperature (8-13).

In this paper, the role of electrochemistry in the bottom-up approach is critically considered. The electrochemical fabrication of “low-dimensional“ metallic nanostructures on foreign metallic or semiconducting substrates using the STM-tip as a nanoelectrode and defined phase formation procedures is discussed. Such electrochemically grown well-defined nanostructures allow detailled investigations of the physical, chemical, electronic, and other properties - at present the most important issue in nanotechnology and possibly the key to a novel technology saving Moore´s law by electrochemical means.

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