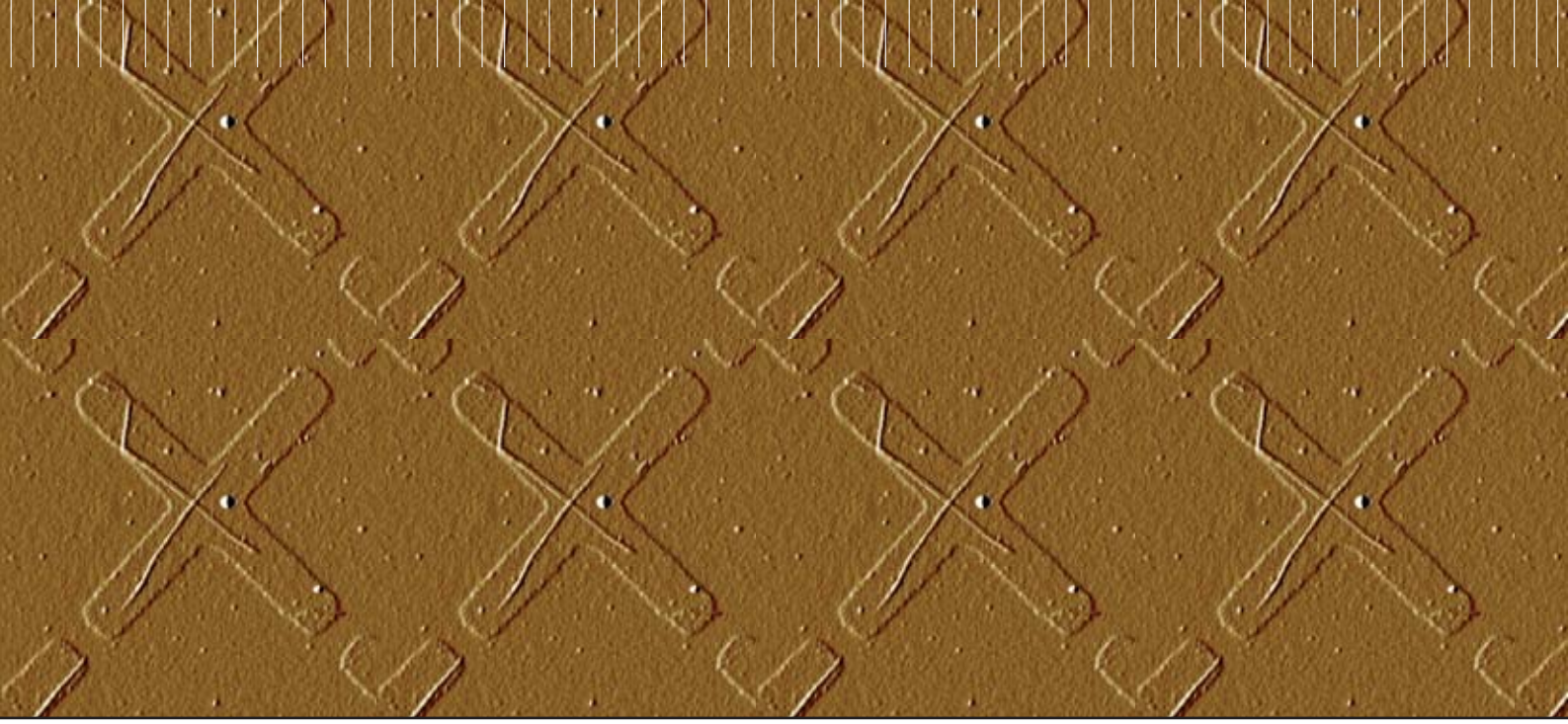

CEA-Motorola

Juxtaposed atomic force microscope images of the same motif of carbon nanotube deposits on a silicon oxide substrate.

II. BUILDING BLOCKS FOR THE NANOWORLD

Chapter two of this issue describes some aspects of the bottom-up approach to nanotechnology, which completes the top-down approach derived from microelectronics. This route involves creating nanometric building blocks, each providing a function, and assembling them to construct increasingly complex objects.

The basic "nanoblocks" will first be described. The now famous carbon nanotube, produced by a now well-controlled synthetic route, can behave like an electric nanowire or an electron-emission tip, or be used to add mechanical strength to a polymer fibre. Semiconductor nanowires represent a new means of building semiconductors and incorporating, in nanometric-sized wires, all the well-known functions of this family of components – transistors, diodes, lasers, etc. Semiconducting nanocrystals, prepared as nanometric particles, display quantum properties that offer new functions, for example as fluorescent markers or light absorbers for photovoltaic cells.

To construct complex objects, these elementary building blocks must be assembled. These tiny objects have to be grasped, accurately positioned and connected up in prescribed ways. The second part of this chapter will address this question of assembly and describe some parts of the possible solutions. It will also deal with the many ways in which these building blocks can be functionalized so that they can execute pre-set tasks.

Molecular electronics aims to take up the challenge of post-CMOS high-density electronics by taking molecules or nanotubes and assembling them to carry out all the usual electronic functions. However, to assemble carbon nanotubes or nanowires to produce electronic components, their surface reactivity and electrical conductance have to be controlled, and they have to be designed to capture biomolecules selectively. The successful use of DNA as a template reminds us that powerful methods of recognition and assembly exist already in living systems. Scientists are confident that analogous processes, including the use of biological molecules to assemble the elementary building blocks, will provide solutions. In addition, carbon nanotubes can themselves act as templates able to recognize and organize biomolecules.

In a quite different field, nanostructured sol-gel materials made from organic-inorganic hybrids make it possible to design new reflective or protective coatings for the optical parts of high-power laser systems. These nanomaterials are also being studied for their electrochemical, electronic, magnetic and biological properties.