Nanoarchitectonics: Basic Concept and Recent Topics

Masakazu Aono

International Center for Materials Nanoarchitectonics (MANA)
National Institute for Materials Science (NIMS)
Namiki 1-1, Tsukuba, Ibaraki 305-0044, Japan
E-mail: AONO.Masakazu@nims.go.jp

Abstract

In 2007, Japan's Government launched the World Premier International Research Center Initiative, i.e. WPI Program. Our International Center for Materials Nanoarchitectonics (MANA) was organized as one of the first five WPI centers.

The reason why we use the new word nanoarchitectonics in the name of MANA is that we believe conventional nanotechnology has to be revolutionized by the concept expressed by the new word nano-architectonics in order to draw the full ability of nanotechnology. Nanoarchitectonics can be regarded as a novel technology system allowing to arrange nanoscale structural units, which are typically a group of atoms or molecules or a complex of them, in an intended configuration. However, nanoarchitectonics is not a simple extension of conventional nanotechnology but aims to move to a new paradigm for nano-technology in materials development, where novel materials with an emergent property are created by designing and controlling mutual interactions between nanoscale structural units. Nanoarchitectonics therefore claims that the conventional analytic view of nanotechnology must yield to a certain synthetic view and also that it must be looked squarely that the conventional concept of precise structural control, which has been widely accepted in microtechnology, does not necessarily hold at the nanoscale.

In this paper, the following four topics are discussed as typical examples of recent researches based on nanoarchitectonics done in MANA.

1) *Nanosheet technology* (one of the most important new materials creation methods based on nanoarchitectonics): This is a unique technology but versatile enough to be applied to create various new materials such as novel dielectric, magnetic, photolectric and superconducting materials.
2) *Atomic switch and its derivatives*: They are not only useful as beyond-CMOS memory and logic devices but also promising in the realization of material-based neuromorphic computational circuits (artificial brain).
3) *Artificial Photosynthesis*: We have already succeeded in the photosynthesis of methane (CH_4) for example by the use of tungsten suboxide ($W_{18}O_{49}$). As the next step, we are making a series of studies to increase the efficiency of photosynthesis.
4) *Decoherence-free novel quantum bit*: Recent remarkable theoretical and experimental researches in MANA are being combined for this purpose.

References

[1] MANA Special Issue on "Advances in Nanomaterials Research and Nanoarchitectonics": *Science and Technology of Advanced Materials* Vol. 11 (2010) No. 5 and Vol. 12 (2011) No. 4.

[2] MANA Special Issue on "Materials Nanoarchitectonics at NIMS": *Advanced Materials* Vol. 24 (2012) No.2.