PREFACE

Focus on Materials Nanoarchitectonics

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On behalf of the International Center for Materials Nanoarchitectonics (MANA), I wish to express our gratitude for the publication of this special issue of Science and Technology of Advanced Materials (STAM), which highlights our recent research activities at MANA. In this preface, I would like to briefly describe the history and then outline the direction of research at MANA.

In 2007, Japan’s Ministry of Education, Culture, Sports, Science and Technology (MEXT) launched the World Premier International Research Center Initiative (WPI Program) to create several frontier research centers in Japan. The aim was to facilitate cutting-edge research by promoting the participation of leading scientists from around the world and by providing an attractive research environment. One of the six centers of the WPI Program is MANA, established at the National Institute for Materials Science (NIMS) in October 2007.

The direction of research at MANA is symbolized by the term ‘nanoarchitectonics’, which is part of the name MANA. What is nanoarchitectonics? In the past quarter century, nanotechnology has made impressive advances and has become an important pillar in the development of new materials. However, to explore its full potential, nanotechnology needs to stay on the path of innovation. In particular, the conventional analytic view of nanotechnology must yield to a certain synthetic approach. This is conducive to creating new functions that can be exhibited by nanoscale structural units through mutual interactions, even though these functions are not present in the isolated units. We coined the term nanoarchitectonics (first used in the name of the 1st International Symposium on Nanoarchitectonics Using Suprainteractions (NASI-1), organized by the author and his colleagues at Tsukuba, Japan, in November 2000) to express this innovation of nanotechnology. More specifically, nanoarchitectonics is a technology system where the aim is arranging nanoscale structural units, which are a group of atoms or molecules or a nanoscale functional component, in an intended configuration that creates a novel functionality through mutual interactions among those units. Materials nanoarchitectonics targets two hierarchical classes of materials development: nanomaterial creation and nanosystem organization.

MANA pursues the nanoarchitectonics concept described above on the basis of five key technologies: (i) controlled self-organization, (ii) chemical nanomanipulation, (iii) field-induced materials control, (iv) novel manipulations of atoms and molecules and (v) theoretical modeling and design. They are harnessed for scientific research organized into four fields: (i) nano-materials, (ii) nano-system, (iii) nano-green and (iv) nano-bio.

In the nano-materials field, various novel nanoscale materials are created by utilizing unique synthetic techniques based on nanoarchitectonics, including soft-chemical, colloid and supramolecular processes. A typical example is the development of nanomaterials using soft-chemical nanosheet technology. In the nano-system field, researchers explore how nanoscale structural elements can produce novel functionalities through their mutual interactions and investigate how such novel functionalities can be materialized using nanoarchitectonics. One example is the development of a nanoscale system formed by atomic switches for the realization of inorganic neuromorphic circuits. The nano-green field develops new materials for electro- and photocatalysts, rechargeable batteries, solar and fuel cells, etc, which are necessary for the realization of a sustainable society.
The nano-bio field sets its research direction towards material therapy and designs new materials for regenerative medicine.

This special issue of STAM contains eleven papers that highlight the recent results obtained in the four research fields of MANA described above, although the main emphasis is placed on the nano-materials and nano-green fields. I hope that this special issue will introduce the research activities of MANA in the four years since its establishment and stimulate collaborations between MANA and other institutions around the world.