Given the significant and time-critical problems of energy shortage, environmental protection, and biomedical issues, the creation of new functional materials and systems for efficient energy production and storage [1,2], environmental remediation with sensitive pollutant detection [3,4], and biological and biomedical applications [5,6] is a crucial matter. In addition to the intrinsic functionality of bulk materials, control of their internal structure on the nanometer-scale is realized to be increasingly important to obtain high efficiency and specificity in their functions. For this general demand, the bottom-up creation of functional materials and systems from nanometer-scale and molecular units using nanotechnology principles is necessary. This can be accomplished by the conceptual fusion of nanotechnology with the other research fields such as atom/molecular manipulation, organic synthesis, supramolecular chemistry, and bio-related technology. This task is assigned to an emerging concept, nanoarchitectonics [7-9].

The nanoarchitectonics concept was initially proposed by Masakazu Aono [10,11] who envisioned the production of functional materials with the following principles: (i) construction of functional materials and systems by organizing nanometer-scale structures (nanounits) even with some unavoidable unreliability; (ii) the properties of the structures may differ from those of the individual nanounits, whereby their interactions may synergistically create new functionalities; (iii) unexpected functionality may be included through assembling or organizing a very large number of nanounits; (iv) new theories and computational approaches are developed to support these fabrication processes. Because the features of the nanoarchitectonics concept are general and applicable to most materials systems,
this concept can be applied to many research targets. In fact, the
nanoarchitectonics concept has already been applied in various
fields, including materials production [12,13], structural fabri-
cation [14,15], sensing [16,17], catalysis [18], energy [19],
environmental [20], devices [21,22], and bio-related [23,24] ap-
lications.

Accordingly, the goal of the thematic issue “Nanoarchitec-
tonics: bottom-up creation of functional materials and systems”
was to collect leading research examples that employ the
nanoarchitectonics concept. These examples range from funda-
mental studies on structural formation and control to applica-
tion-oriented approaches in biology, physical science, and
device technology.

As examples of some fundamental studies on the formation and
control of nanounits, in one work, the chiral structure was found
to control the self-assembly of nitrocinnamic amide
amphiphiles [25]. Works related to the formation of higher-
dimensional materials included, for example, the self-assembly
of crystalline cellulose oligomers that resulted in nanoribbon
networks [26], silicon nanowires that were formed by metal-
assisted chemical etching (MACE) [27], and the formation of
high-tolerance crystalline hydrogels from cyclic dipeptides
upon self-assembly [28]. In addition, a review on the use of
DNA as the fundamental material building block for molecular
and structural engineering [29] gives insight into this interest-
ful field of research which has great potential.

The nanoarchitectonics concept has been applied for various
bio-related applications, for example, in the small-protein-in-
duced cellular uptake of complex nanoarchitectures [30], the
targeted drug release from layered double hydroxide/sepiolite
hybrids [31], and cell surface engineering with halloysite-doped
silica cell imprints for shape recognition of human cells [32].
In another example, magnetic nanoparticles were attached to
microbubble shells for enhanced biomedical imaging [33]. In
a final example, the detection of the prostate-specific antigen
biomarker was expedited by application of advanced data process-
ing and computational tools [34]. The molecular architecture
plays a crucial role for obtaining high sensitivity and speci-
icity in immunosensors, thus tools which speed up the ability
to analyze the large amounts of data produced could significant-
ly contribute to the field of immunosensing.

Some terrific examples of the application of the nanoarchitec-
tonics concept for engineering applications and the physical
sciences include a report by Ruiz-Hitzky et al., where they sum-
marize how photoactive clays incorporating TiO2 and ZnO
nanoparticles exhibit distinct and useful properties [35]. Other
examples include a self-assembled MoS2-based composite that
was developed for energy conversion and storage purposes [36],
a silver-nanoparticle/cellulose-nanofiber composite that was
applied for surface-enhanced Raman spectroscopy [37], bio-
nanocomposites with clay nanoarchitectures for electrochemi-
al devices [38], a biomimetic nanofluidic diode with poly-
meric carbon nitride nanotubes [39], and a unique Janus-micro-
motor applied as a luminescence sensor for sensitive TNT
detection [40].

The variety of nanoarchitectonics approaches collected in this
thematic issue strikingly demonstrates the wide-range applica-
tion of this concept. In addition to the bottom-up creation of
new functional materials and systems, the inclusion of several
additional factors, such as biocompatibility [41] and connection
with wet ionic systems [42] that are low cost and emission-less
in nature, would facilitate the development for practical usage
in the near future.

Katsuhiko Ariga
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ORCID® iDs
Katsuhiko Ariga - https://orcid.org/0000-0002-2445-2955

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