Nanostructuring has visibly grown in stature, strength and significance to be a technically viable and economically affordable method for enhancing the properties of a wide range of metals, alloys, and their composite counterparts for selection and use in a spectrum of advanced structural applications and functional applications, spanning the domains of both performance-critical and non-performance critical. To date, it is well established that bulk nanostructured materials [BNMs] can be successfully produced by microstructural refinement using severe plastic deformation [SPD], which is essentially heavy straining of the chosen material under conditions of high imposed pressure. Severe plastic deformation [SPD] processing is an attractive procedure for many advanced applications as it contributes in an observable way to enhancing the properties of a wide range of metals, alloys, and their composite counterparts. Metallic materials subjected to severe plastic deformation [SPD] tend to possess not only an ultrafine grain (UFG) structure but also specific nano-structural features, to include the following: (i) non-equilibrium grain boundaries, (ii) nano-twins, (iii) grain boundary segregation, and (iv) nanoparticles. The development and emergence of nanostructured materials led them to be defined as solids having a combination of grains, sub-grains, twin, or dislocation cells of size below 100 nm. Such materials usually offer a combination of superior mechanical properties and physical properties to include the following: (i) high strength, (ii) improved corrosion resistance, and (iii) good wear resistance. Over the years, two complementary approaches have been developed for synthesizing nanostructured solids. The first is the “BOTTOM-UP” approach. In this approach, the nanostructured materials are neatly assembled from individual atoms or nanoscale building blocks, such as nanoparticles. The second is the “TOP-DOWN” approach. In this approach, the existing coarse-grained material is processed to produce a substantial refinement in grain size and eventually a nanostructured material.

The most successful “TOP-DOWN” approaches involve the application of large plastic deformation in which the chosen material is often subjected to large plastic strains typically larger than 4-6. The plastic deformation tends to refine the grains by a synergistic combination of several concurrent and competing mechanisms to include the following: (i) dislocation glide, (ii) dislocation accumulation, (iii) dislocation interactions, (iv) dislocation annihilation, (v) tangling, and (vi) spatial rearrangement. For materials having medium stacking fault energy and low stacking fault energy, deformation twinning does play a significant role, especially for the nanocrystalline grains. The intricacies specific to microstructural evolution does tend to vary with the following: (i) nature of chosen material, (ii) deformation mode, (iii) strain rate, and (iv) temperature. The goal of both understanding and controlling materials at the nanoscale gradually led to noticeable advances in technology, culminating in the emergence of visible and applicable societal benefits.

The early hype with specific reference to the benefits offered by nanotechnology led to several viable applications, such as (i) medical instruments, (ii) high-performance computers with sizeable data storage, (iii) high-efficiency energy conversion, and (iv) storage devices. In the early days, news articles specific to the benefits of nanotechnology outpaced the number of awarded patents. However, this trend gradually reversed, and successful nanotechnology patents and products tend to outnumber the popular “news” stories. The nanotechnology inspired grand challenges listed by the U.S. National Academy of Sciences to include the following:

(a) An increase in the five-year survival rate by as much as 50 percent for the most difficult to treat cancers.
(b) Create devices no bigger than a grain of rice that can sense, compute and communicate with wires while concurrently being maintenance-free for at least 10 years, enabling a revolution of the “internet of things.”
(c) Create computer chips that are 100 times faster and consume significantly less power.
(d) Manufacture atomically precise materials having 50 times the strength of pure aluminum but at half the weight and same cost;
(e) Reduce the cost of turning seawater into drinkable water by a factor of four, and
(f) Determine the environmental, health and safety characteristics of the chosen nanomaterial.

The objectives of this “special-issue” being dedicated in honor of the Editor-in-Chief Dr. Manoj Gupta (of the National University of Singapore) is to bring together a collection of technical papers that reflect on the noticeable and commendable progress that has been made in the domains specific to innovation, development, and applications of the family of nanomaterials. The focus on nanoscience, nanomaterials, and nanotechnology has provided noticeable advancement in both
our ability and capability to synthesize, characterize and engineer nanomaterials having a unique combination of physical properties, chemical properties, and mechanical properties. This has been made possible by providing constraints to the dimensions. In applications related to technology where engineered components must bear the load, structural nanomaterials show much promise and put to effective use the trend/concept “smaller is stronger.” This “special issue” of Current Nanomaterials does bring together a collection of 6 papers that have been included in this “specific” issue. The six technical manuscripts included in Part 2 of this “special issue” span the following key topics:

1. The Influence of Processing Methods on Corrosion Rates of Magnesium-carbon Nanotube Nanomaterials: A Review
2. Carbon and Metal-Based Nanomaterials for Strain Sensors: A Review
3. Development of Magnesium Nanocomposites by Powder Metallurgy for Multifunctional Applications: A Review
4. Nano Hydroxyapatite (NANO-HAOP): A potential Bioceramic for Biomedical Applications
5. Magnesium-Based Hybrid Nanocomposites: An Insight into Nanoparticle Effects on Microstructure and Mechanical Properties
6. Effect of Nano silica on strength and Water Absorption of Cement Mortar Exposed to low-Pressure Environment

These six papers attempt to provide adequate information specific to the state of the art developments on all aspects related to the following: (i) Processing, characterization, and fabrication of nanomaterials spanning the specific domains of metals and composites, (ii) Properties and mechanical behavior, (iii) Preparation to include applications and the role of reinforcement and water absorption, (iv) Role of powder metallurgy in development nanocomposite materials, and (v) Nanomaterials for bio-medical related applications.

The primary objective of Part 2 of this “special issue” is to present important results to both the material-related and technology-relevant communities in the form of technical papers that address aspects specific to innovations in research, viable developments, noticeable design, and technology-relevant applications. The collection of papers assembled should be of value to researchers, scientists, relevant and involved engineers, appropriate manufacturers and potential end-users in keeping themselves abreast with new developments in their area of specialty and to come together in their effort to bring forth novel innovations in technology and resultant applications. Also, the collection of six papers included in Part 2 of this “Special Issue” of the journal does attempt to provide a cohesively complete and compelling overview of recent developments to include innovations and advances in the specific domain of nanomaterials and nanotechnology, concurrent advances in the processing and characterization of these novel materials, emerging developments and the potential far-reaching applications for these materials commensurate with development and concurrent advances in the domains specific to engineering and technology.

Part 2 of this “Special Issue” on aspects both related and relevant to Innovations, Advances and Applications of nanomaterials and resultant nanotechnology is an easily understandable background and platform that will certainly provide the much-needed impetus to both the ‘interested’ reader and the ‘inquisitive’ researcher to understand the potential for these materials by way of innovation to inspire their selection and use in a spectrum of technology-related applications, including both performance-critical and non-performance critical.

We anticipate Part 2 of this “Special Issue” [in honor of Dr. Manoj Gupta (National University of Singapore)] to be of noticeable value and “valued” interest to a sizeable number of individuals spanning academicians, scientists, engineers, technologists, and even entrepreneurs.

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