Association of Metallurgical Engineers of Serbia *Technical paper*
AMES *UDC:389.15=861*

TERMINOLOGY FOR NANOMATERIALS AND NANOTECHNOLOGY

ТЕРМИНОЛОГИЈА НАНОМАТЕРИЈАЛА И НАНОТЕХНОЛОГИЈЕ

BRANKO MATOVIĆ, SNEŽANA BOŠKOVIĆ

Institute of Nuclear Sciences "Vinca" Material Science Laboratory, Belgrade

ABSTRACT

This article is dealined with the terminology in nanomaterials and nanotechnology. Many terms and labels have been used with the prefix "nano" in practice, as well as in science and engineering. This causes misunderstanding in the real meaning of such terms. However, it is very important to establish precise definitions that can explain the nanomaterials as a part of nanoworld in the context of basic sciences and technology. This article proposes a nomenclature for the nanomaterials and nanotechnology collected from the existing literature. A simplified explanation of some essential terms is given, in addition.

Key words: nanosize, nomenclature, nanoworld, nanomaterials, nanotechnology.

ИЗВОД

Овај документ објашњава основне појмове из наноматеријала и нанотехнологија. Данас се свакодневно сусрећемо са терминима који почињу са префиксом "нано" који су доста непрецизни и често потпуно нетачни. Зато је веома важно да се у научној и техничкој литератури јасно одреди поље егзистенције наноматеријала и утврди њихов однос према другим врстама материјала, као и основним природним наукама. У том погледу је у раду дат предлог номенклатуре за наноматеријале и нанотехнологије, која би требала да јасно објасни основне термине ове нове науке.

INTRODUCTION

It is considered today that a new revolution in science and technology has started [1, 2]. This is nano-revolution. However, what exactly does it mean and how will it change the life of people in the future is still not really understood. To start to understanding of what does it mean we tried to comprehend the terminology risen in the fields in connection to materials science. Condensed matter physics study the solids of infinite array of bound atoms with dimensions greater than 100 nm. Chemistry dealing with atoms and molecules with dimension less than one nanometer. Thus, a huge gap exists between them (Table 1). This significient gap represents nanomaterial as a part of nanoworld.

Table I - Size and the number of atoms relationships of chemistry, nanoworld and condensed matter physics

	Quantum Chemistry	Nanomaterials	Condensed Matter
N° Atoms	1	$10 - 10^6$	$6 \cdot 10^6 - \infty$
Diameter (nm)	< 1	1 - 100	$100 - \infty$

In this nanoscale regime neither quantum chemistry nor classical laws of physics work properly [3]. Obviously a nanomaterial is a new field of science that involves the quantum chemistry, materials science and solid state physics. It is connected with classical materials by means of the length of their particle size [4]. Any type of solids (ceramics, metals, composites, polymers...) belong to nanomaterials if their particle size is in nanoscale regime (below 100 nm) [5, 6].

Nanomaterial is consisting of a collection of units (atoms, molecules) with an average grain size below 100 nm. Clusters of atoms or the cluster assembles of one or two dimensionality build multylayers, and three-dimensional structures. Nanomaterials can behavior as a structure of zero dimensionality. Due to endless possibilities of arranging of clusters, very often-cumbersome expression is used in literature. The continuing rise in the number of relevant publications on the subject of nanomaterials requests the strict definitions of its terminology.

DEFINITIONS

Nanoparticle is a basic unite of nanoworld. It is a solid particle in the 1 - 100 nm range that exhibits size dependent properties. This behavior is due to a high surface area as well as high surface to volume ratio. For example, a 3 nm particle has 50% of its atoms on the surface, whereas in a 10 nm particle about 20% of atoms are on the surface and 30 nm particles only 5% of atoms are on its surface.. These surface atoms are in non-equilibrium state, giving rise to new physical and chemical properties. Thus, properties depend on critical length scale.

Critical length scale is the size of particle representing the starting point from which the fundamental physical a chemical properties undergo changes and keep on being changed with further decreasing particle size.

Nanostructured materials or ***nanoscale materials*** are any solid materials with nanosize dimension:

- ***Particles*** → three dimensions,
- ***Thin films*** → two dimensions and
- ***Thin wire*** → one dimension.

Nanocrystal is a solid particle that has a well-defined crystal form which lies in the nanosize range.

Nanocomposites are the solids composed of different components in which one or all of them have a size of structural blokes in the nanoscale range. A huge number of combinations (ceramics, metal, polymer or their mixtures) could be considered.

Quantum dots are particles that posses a size unitization effect in at least one dimension. These are small semiconductor boxes that hold a limited number of electrons for selective retention or release depending on quantum well structure.

Quantum well structure describes a small semiconductor box that can ensnare particles (electrons, holes), which have quantum confinement due to restriction of their motion with well dimensions.

Clusters are groups of atoms (≥ 3 atoms) that behave different from individual atom or bulk materials of the same species.

Colloids are part of a stable liquid phase containing nanosizes particles.

REFERENCES

[1] R. Notzel and K. H. Ploog, Adv. Mater., 5 (1993) 22.

[2] H. Gleither, Adv. Mater., 5 (1992) 474.

[3] K. J. Klabunde, Nanoscale Materials in Chemistry, John Wiley, New Jork, 2001, p. 6.

[4] P. Ayyub, V. R. Palker, K. H. Hardtl and M. Multani, Phys. rev., B51 (1995) 6135.

[5] H. Glieter, Nanostruct. Mater., 6 (1995) 3.

[6] M. N. Rittner and T. Abraham, Int. J. Powder Metall., 34 (1998) 33.