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APPLICATIONS OF NANOMATERIALS

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Abstract

Nanomaterials (nanocrystalline materials) are substances possessing grain sizes on the order of a billionth of a meter. They manifest extraordinarily charming and beneficial properties, which can be exploited for a ramification of structural and non-structural packages. seeing that Nanomaterials own unique, beneficial chemical, bodily, and mechanical houses, they may be used for an extensive form of programs, like next era laptop Chips, Kinetic power (KE) Penetrators with more advantageous Lethality, better Insulation materials, Phosphors for excessive-Definition tv, Low-cost Flat-Panel displays, more difficult and more difficult cutting tools, elimination of pollution, excessive strength Density Batteries, excessive-power Magnets, high-Sensitivity Sensors, motors with greater gas efficiency, Aerospace additives with superior performance characteristics, higher and destiny weapons platforms, Longer-Lasting Satellites, Longer-Lasting medical Implants, Ductile, Machinable Ceramics, huge Electro chromic show devices.

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1. Introduction

Nanotechnology is the re-engineering of materials and devices by controlling the matter at the atomic level (Roco et al., 1999).
In other words, nanotechnology is a field that is dominated by developments in basic physics and chemistry research

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(Chong 2004), where the phenomena on atomic and molecular levels are used to provide materials and structures that perform tasks that are not possible using the materials in their typical macroscopic form. The evolution of technology and instrumentation, as well as its related scientific areas, such as physics and chemistry, is making the research on nanotechnology aggressive and evolutional (Chong 2002). A more accurate definition of nanotechnology was presented in 1981 by Drexler (Drexler1981), such as the production with dimensions and precision between 0.1 and 100 nm. Inmedium terms, nanotechnology involves the study at microscopic scale (1 nm = 1 × 10 -9 m).

As a comparison, one must realize that a strand of human hair has 80,000 nm thickness and that the DNA double helix has 2 nm diameter. Between 1997 and 2003, the investment in nanotechnology increased at 40%, reaching up to 35,000 million Euro (Andersen et al., 2007).

Some estimates predict that products and services related to nanotechnology could reach 1,000,000 million Euro per year beyond 2015 (NSF 2001).

According to the report of RILEMTC 197-NCM, "Nanotechnology in construction materials" Zhu et al., 2004), is the first document that synthesis in a clear manner the potential of a nanotechnology in terms of the development of construction and building materials, namely:- The use of nano-particles, carbon nano-tubes, and nano-fibers to increase the strength and durability of cementitious composites, as well as for pollution reduction.

1. Production of cheap corrosion free steel.
2. Production of thermal insulation materials with performance of 10 times the current commercial options.
3. Production of coats and thin films with self-cleansing ability and self-colour change to minimize energy consumption.

In nano-level, gravity becomes unimportant, electrostatic forces take over, and quantum effects come in. Furthermore, as particles become nano-sized, the proportion of atoms on the surface increases relative to those inside, and this leads to novel properties. Current researchers dealing with nano-science and nanotechnology are exploring these novel properties since at nano-scale, we can alter the macro-properties and produce significantly new materials and processes. Discussion on the application of nanotechnology in civil engineering, specifically in construction, is extremely important. According to a study by the Canadian Program on Genomics and Global Health (CPGGH), nanotechnology in civil engineering was ranked 8 of 10 applications that most likely have an impact in the developing world (ARI News 2007).

2.APPLICATION OF NANOTECHNOLOGY IN CONSTRUCTION

Many disciplines of civil engineering, including design and construction processes, can be benefited from nanotechnology. These include products that are for: Lighter structure, Stronger structural composites, e.g. for bridges and others. Low maintenance coating, Improved pipe joining materials and techniques, Better properties of cementations materials, Reduced thermal transfer rate of fire retardant and insulation, Increased sound absorption of acoustic absorber, Increased reflectivity of glass, water repellents, nano-clay filled polymers, self-disinfecting surfaces, UV light protector, air cleaners, nano-sized sensors, and solar cells.Vol. 19 [2014], Bund. T 4675.There are a large number of applications of nanotechnology in the construction engineering/industry. Some of these applications are examined in detail below. Nano-cement Portland cement is the most widely used construction materia Selection.

It can be argued that concrete utilizes nanotechnology because it contains nano-particles as its ingredients, including nano-water particles and nano-air voids. However, it is not the application of the technology at nano-level. If it is possible to create the technological tools and organize the amount and locations of these nano-ingredients in a scientific way, then, concrete can experience the advances of nanotechnology. Concrete is, after all, a macro-material, strongly influenced by its nano-properties and understanding it at nano level can provide the avenues for improvement of strength and durability. The particle size of cement can be reduced to nano-size or can be modified by adding nano-tubes and reactive nano-size silica particles. A number of investigations have been carried out to develop smart concrete using carbon fibers (Chong et al., 2002) and it has been found that instead of carbon fibers, nano-carbon tubes added with nano-cement are more effective.

2.1.Nano-composites

Nano-composites can be developed by using nano-tubes, which can implant some of the outstanding properties of the nano-tubes. Alumino-silicates are mixed with carbon nano-tubes,which can produce strong and durable conductive films. Furthermore, the current sizes of alumino-silicates (50 to 100 nm) can further be reduced to 5 to 10 nm range, and a little volume percent of nano-tubes (≈ 0.5%) can produce extraordinary composites. Besides, fibre wrapping that has been commonly used to strengthen the existing concrete structures has witnessed advancement by using fibre sheet (matrix) containing nano-silica particles and hardeners (Ge et al., 2008). These nano-particles penetrate and close small cracks on the concrete surface and, in strengthening applications, the matrices form a strong bond between the surface of the concrete and the fibre reinforcement.

22.Mineral and Metal Nano-materials to Improve

A part from the structural change caused by heat-treatment, fungicide property of some minerals at nano-scale can also improve the biological durability of wood and wood-composite materials. In this regard, wollastonite nano-fibers (NW) have been reported to substantially improve the durability in poplar wood (Karmi et al., 2013). NS, NC, and nano-zinc oxide have also been reported to improve the resistance to Trametesversi color, a white-rot fungus (Akhtari et al., 2013). Nano-silver and NW have also been reported to significantly improve fire-retarding properties in solid woods and wood-composite materials (Taghiyari et al., 2012, 2013). The high thermal conductivity coefficients of NS and NW materials have been reported to primarily transfer heat throughout the body of wood, preventing accumulation of heat over the surface layer, and eventually decrease the temperature below the ignitability of wood components. Furthermore, as a mineral material, NW helps fire resistance in a second way by acting as an impermeable physical barrier towards flame. NW forms a fire barrier towards the penetration of flames into the body of wood structure. In this sense, NW acts similarly to intumescent paints.Vol. 19 [2014], Bund. T 4676

2.3.Nano-coatings for Concrete

In order to protect the structures/components from abrasion, chemical attack and hydrothermal variations, and to improve aesthetics, chemical coatings are generally and routinely used. Till date, technology which limits the size of coating materials in micrometer can enjoy great advancement by using nano-science and technology. Studies are being conducted on the types of nano-particles in various binders and their effectiveness on key properties related to concrete deterioration, and it has been reported that a solvent containing a low molecular weight epoxy resin and nano-clay particles has shown promising results. Nano-meter thick coatings are durable and could have self-cleaning and self-healing properties. Nano-scale roughness of the coatings has the property to repel water and dirt, and can outdate the existing 'non-stick' technology. Self-cleaning properties of a coating made using nano-particles would also help to keep the coated surface totally free of dirt and dust (Balaguru 2007)

2.4.Nano-steel

Steel has played a major role in the construction industry since past two centuries. Fatigue is a significant issue for the structures subjected to cyclic loading, such as in bridges, towers, and off-shore platforms. Fatigue failure can occur at significantly low stresses than the yield stress of the material and lead to a significant reduction in service life. Stress concentration is responsible for initiating cracks which triggers fatigue failure, and research has shown that the addition of copper nano-particles reduces the surface unevenness of steel, which then limits the number of stress risers, and hence fatigue cracking. Furthermore, it has been reported that vanadium and molybdenum nano-particles can improve the fracture problems associated with high strength bolts (Nippon 2005).

Microscopy Methods

The most important and popular instruments for the investigation of nano-scale in civil engineering are listed below.

Atomic Force Microscopy (AFM): AFM is a kind of scanning probe microscopes (SPM). SPMs are designed to measure local properties, such as height, friction, and magnetism, with a probe. AFM provides a 3D profile of the surface on a nano-scale, by measuring the forces between a sharp probe (<10 nm) and surface at a very short distance (0.2- 10 nm probe-sample separation). The probe is supported on a flexible cantilever. The AFM tip "gently" touches the surface and records the small force between the probe and the surface.
The AFM can be used to study a wide variety of samples (i.e. soil, concrete, plastic, metals, glasses, semiconductors, and biological samples, such as the walls of cells and bacteria).

Scanning Electron Microscopy (SEM): A SEM instrument shows the electron column, sample chamber, EDS detector, electronics console, and visual display monitors. The SEM uses a focused beam of high-energy electrons to generate a variety of signals at the surface of solid specimens. The signals that derive from the electron-sample interactions reveal information about the sample, including external morphology (texture), chemical composition, crystalline structure, and the orientation of materials making up the sample. In most applications, data are collected over a selected area of the surface of the sample, and a 2- dimensional image is generated that displays spatial variations in these properties. Areas ranging from approximately 1 cm to 5 microns in width can be imaged in a scanning modeusing conventional SEM techniques (magnification ranges from 20X to approximately 30,000X, spatial resolution of 50 to 100 nm). SEM is also capable of performing analyses of selected point locations on the sample. This approach is especially useful in qualitatively or semi-quantitatively determining chemical compositions (using EDS), crystalline structure, and crystal orientations (using EBSD). The design and function of the SEM is very similar to the EPMA and considerably overlap in the capabilities that exist between the two instruments.

3.Conclusion

Based on the short review in this paper, nanotechnology has the potential to be the key to a brand new world in the field of construction and building materials. Although replication of natural systems is one of the most promising areas of this technology, scientists are still trying to grasp their astonishing complexities. Furthermore, nanotechnology is a rapidly expanding area of research where novel properties of materials manufactured on nano-scale can be utilized for the benefit of construction infrastructure, and a number of promising developments exist that can potentially for infrastructure to make a new world in the future.

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