RESEARCH ARTICLE OPEN ACCESS

Application of Nanotechnology in Civil Infrastructure

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Abstract
In this article, use of nanotechnology in building materials on behalf of a range of civil engineering mechanism is discussed. In view of the fact that the use of nanotechnology controls the topic at the minute level, the properties of matter are sincerely affected. Strength, durability and other properties of materials are dramatically affected under a scale of nano meter(10-9m).This article as well reveals how the use of nano technology makes concrete more stronger, durable and more easily placed. Different types of nano materials used are discussed with its wide applications. The properties like self-sensing, self- rehabilitation, self-structural health monitoring, self-vibration damping, self-cleaning and self-healing are studied. Following this the analysis were carried out in ductile structural composites along with its improved properties, low repairs coatings, better properties of cementitious materials, reduction of the thermal transfer rate of fire retardant and insulation, various nanosensors, smart materials, intellectual construction technology.
Keywords: Civil Infrastructure Application, Nanotechnology properties.

I. INTRODUCTION

Nanotechnology is the use of very small particles of material either by themselves or by their manipulation to create new large scale materials. Nanotechnology is not a new science and it is not a new technology, it is rather an extension of the sciences and technologies that have already been in development for many years. Nanotechnology is the re-engineering of materials by controlling the matter at the atomic level. The key in nanotechnology is the size of particles because the properties of materials are dramatically affected under a scale of nano meter [10-9 meter]. Further, as particles become nano-sized the proportion of atoms on the surface increases relative to those inside and this leads to novel properties. Concrete is stronger, more durable and more easily placed, steel tougher and glass self-cleaning. Increased strength and durability are also a part of the drive to reduce the environmental footprint of the built environment by the efficient use of resources.

II. Nanotechnology

Nanotechnology is the understanding and manages of matter at dimension of approximately 1 to 100 nanometers; everyplace unique phenomena enable novel applications."Encompassing nanoscale science, engineering and technology, nanotechnology involves imaging, measuring, modeling, and manipulating matter at this length scale. Nanotechnology, shortened to "nanotech", is the study of the controlling of matter on an atomic and molecular scale. Generally nanotechnology deals with structures sized between 1 to 100 nanometer in at least one dimension and involve developing materials or devices within that size.

III. Uses of Nanotechnology in Civil infrastructure

Nanotechnology can be used for plan and construction processes in many areas ever since nanotechnology generates products have many only one of its kind characteristics. These characteristics can, again, considerably fix present creation tribulations, and may adjust the requirement and associations of construction process.Some of their applications are examine in detail below.

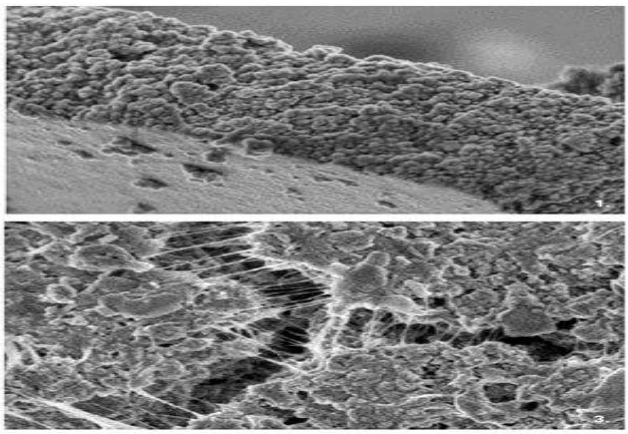
IV. Concrete

Concrete is one of the most common and widely used manufacture materials. Nanotechnology is widely used in studying its properties like hydration reaction, alkali silicate reaction (ASR) and fly ash reactivity. Alkali silicate reaction is caused due to alkali content of cement and silica present in reactive aggregates like chert. The use of pozzolona in the concrete mix as a partial cement replacement can reduce the likelihood of ASR occurring as they reduce the alkalinity of a pore fluid. Fly ash not only improves concrete durability, strength and, importantly for sustainability, reduces the requirement for cement, however, the curing process of such concrete is slowed down due to the addition of fly ash and early stage strength is also low in comparison to normal concrete.

Addition of Nano-silica leads to the densifying of the micro and nanostructure resulting in improved mechanical properties. With the addition of

nano-SiO_2 part of the cement is replaced but the density and strength of the fly-ash concrete improves particularly in the early stages. For concrete containing large volume fly ash, at early age it can improve pore size distribution by filling the pores between large fly ash and cement particles at Nano scale.

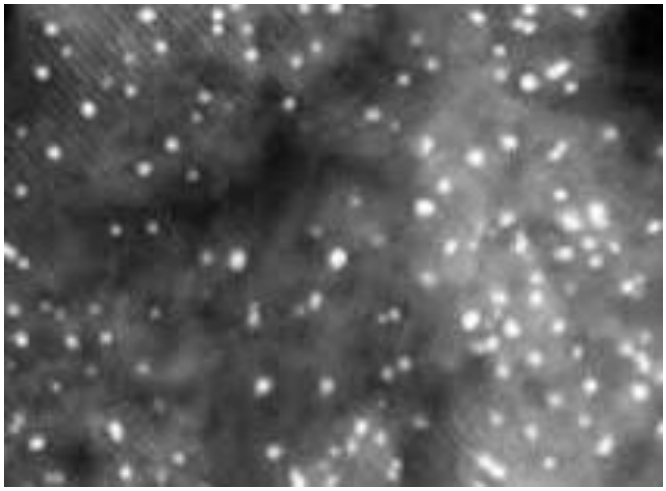
Synthesized cementations nanoparticles, and Carbon nano tubes bridging cracks in cement composite, Nanolayered calcium aluminates particles.



V. COATINGS

The coatings incorporate certain Nano particles or Nano layers have been developed for certain purpose including: protective or anti-corrosion coatings for mechanism; self-cleaning, thermal control, energy saving, anti-reflection coatings for glass/windows; easy-to-clean, antibacterial coatings for work surfaces; and more durable paints and anti-graffiti coating for buildings and structures.. This coating works in two stages. First, using a 'photocatalytic' process, nanosized TiO_2 particles in the coating react with ultra-violet rays from natural daylight to break down and disintegrate organic dirt. Secondly, the surface coating is hydrophilic, which lets rainwater spread evenly over the surface and 'sheet' down the glass to wash the loosened dirt away. It can therefore reduce airborne pollutants when applied to outdoor surfaces. Coating of 7000 m^2 of road surface with such a material in Milan in 2002 has led to a 60% reduction in nitrogen oxides concentration at street level [22]. Research has also demonstrated that bimetallic Nano particles, such as Fe/Pd, Fe/Ag, or Zn/Pd, can serve as potent reductants and catalysts for a large variety of environmental contaminants [11].

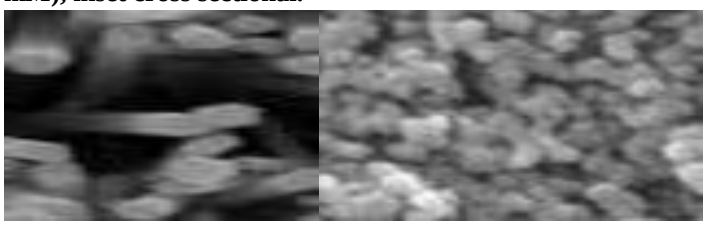
FE-SEM image of CdSe nanocrystalline film on glass coated with 10 nm Au nanoparticles. The Au nanoparticles are spherical and nearly 10 nm in diameter.



VI. Glass

Fire-protective glass is another application of nanotechnology. This is achieve by using a clear in tumescent layer sandwiched between glass panel (an interlayer) formed of fumed silica (SiO_2) nanoparticles which turns into a rigid and opaque fire shield when heated. The electro chromic coatings are being urbanized that react to changes in applied voltage by using a tungsten oxide layer; thereby becoming more opaque at the touch of a button. Because of the hydrophobic properties of TiO_2, it can be applied in antifogging coatings or in self-cleaning windows [1]. Nano-TiO_2 coatings can also be applied to building exteriors to prevent sticking of pollutants, and thus reduce a facility's maintenance costs [15].

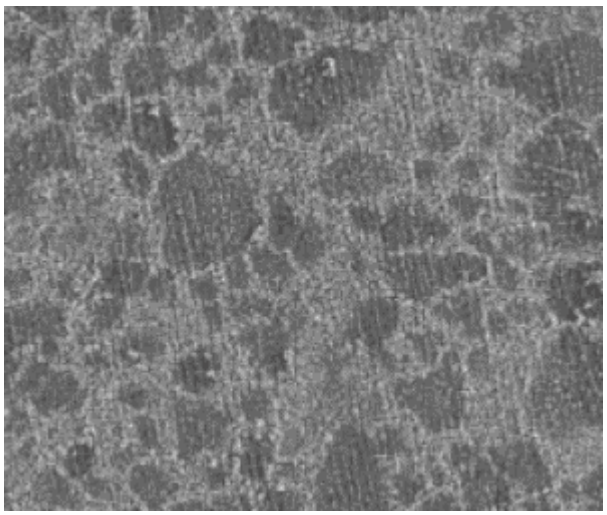
Scanning electron micrograph of ZnO nano particle thin film on glass substrate, Sample 1 (0.1 mM), inset cross sectional.



VII. Steel

Steel has been widely available since the second industrial revolution in the late part of the 19th and early part of the 20th Century and has played a major part in the construction industry since that time. Fatigue is a significant issue that can lead to the structural failure of steel subject to cyclic loading, such as in bridges or towers. This can

happen at stresses significantly lower than the yield stress of the material and lead to a significant shortening of useful life of the structure. The current design philosophy entails one or more of three limiting measures: a design based on a dramatic reduction in the allowable stress, a shortened allowable service life or the need for a regular inspection regime. Stress risers are responsible for initiating cracks from which fatigue failure results and research has shown that the addition of copper nanoparticles reduces the surface unevenness of steel which then limits the number of stress risers and hence fatigue cracking. **Surface of the stainless steel after electro deposition of palladium nanoparticles at low and high magnifications are shown.**



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VIII. CONCLUSION

Nanotechnology offer infinite amounts of improvement in the civil engineering field. It has help improve the quality of and solved many issue with building materials such as concrete and steel. The use of nanotechnology has also helped formed more efficient also sustainable materials such as self-cleaning and self-repairing concrete and window. The use of coatings made from nanotechnology helps get better fire-resistance, corrosion protection, insulation, and innumerable other applications. Nanotechnology can even help improve the quality and availability of water. As a expected future civil engineer, this type of technology is of greatest importance to me as I will have to work with nanotechnology in my future. When looking at all of these innovations and improvements upon construction and environmental areas, it can be clearly observed that nanotechnology is of especially important to the field of civil engineering and requirements to be bring into the engineering program of study at school. Nanotechnology is important to the future and improvement of civil engineering; on the other hand it cannot contribute to the field if it is not skilled on a wider level as well as to every aspiring civil engineer.

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