

APPLICATION OF NANOTECHNOLOGY IN THE FIELD OF CONSTRUCTION

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Abstract

The research paper showcases an elaborate study of nanotechnology which is one of the most advanced technologies and is important for the future of human society. The application of nanotechnology can increase the structure of the properties of building materials, like steel, insulation, and concrete. This paper will also discuss the versatile use of this technology and elaborate on the different advantages and disadvantages of nanotechnology in construction projects.

Keywords- bottom-up and top-down theory nanotechnology, Nanoparticles, Nanomaterials, Nanofabrication

I. INTRODUCTION

Nanotechnology is one of the modern technologies which is decisive for the future of human society [1]. In addition, nanotechnology has a versatile use that determines different factors of the use of the technology. Construction industries have various applications of nanotechnology. Thus, the following study has discussed the implication of nanotechnology in the construction industry. Moreover, the implication of nanotechnology is described using the Sputtering model of combining nanoparticles and creating small structures beneficial for construction. In addition, the implication of different branches of nanotechnology is described according to implications in the construction sites. Moreover, a detailed systematic analysis of the implication of related to nanotechnology in the construction industry.

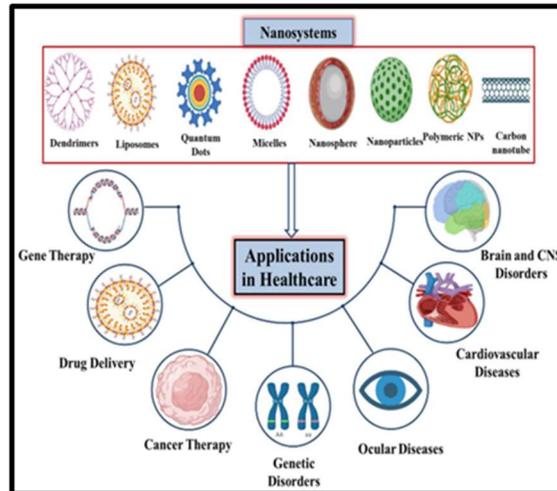


Figure 1: implication of nanotechnology (Source: 2)

II. OBJECTIVES

In order to describe the topic following objectives were created:

- To elaborate on different factors related to Nanotechnology.
- To elaborate on the different methods of nanotechnology in construction
- To analyse nanotechnology with the help of respective theory
- To discuss the problems related to the implication of nanotechnology in the construction industry
- To describe the advantages and disadvantages of nanotechnology

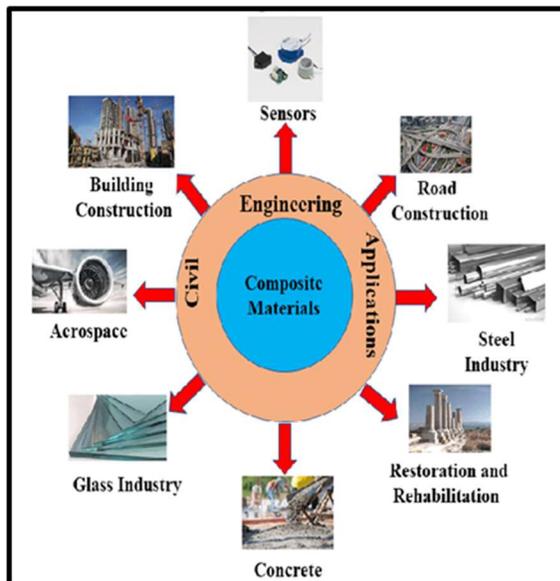


Figure 2: implication of nanotechnology in construction (Source: 3)

III. METHODOLOGY

The methodology of the research is an important aspect of research that determined the different steps used to develop the study [5]. In addition, the final outcome of a study depends on the methods considered for a study. In order to describe the implication of nanotechnology in construction sites secondary data was collected from different past research. In addition, qualitative analysis was used in order to analyse the data qualitative method off analysis was used in the study. Moreover, secondary qualitative methods of analysis provided a wide spectrum related to the study [11]. Therefore, the study is presented as an appropriate source of knowledge related to nanotechnology in the construction industry.

IV. DIFFERENT KINDS OF NANOTECHNOLOGY

The basis of molecular technology stands on the concept of building small and functional technological pieces in order to serve a specific purpose the following branches of nanotechnology have different implications for the construction industry.

A) Molecular assembler: in the technology of molecular assembler the core concept is related to producing an object atom by atom or molecule by molecule [6]. However, the Molecular assembler technology is mainly used at a molecular level and thus has limited use in the construction industry. However, there are numerous possibilities hence there might be a way to use a Molecular assembler in construction based on the implications [7].

B) Nano-robotics

Nano-robots have versatile and are used in the construction industry. Moreover, the implication of nanorobotics helps to reduce the time in the construction industry [10]. Additionally at the same time helps to produce a better product, mostly nanobots are used in medical science for drug delivery, reproductive biology and other similar means. However, it is estimated that nano-bots can be used in the construction industry. Specifically, nano-bots can be used for performing small repairs in the construction industry [8].

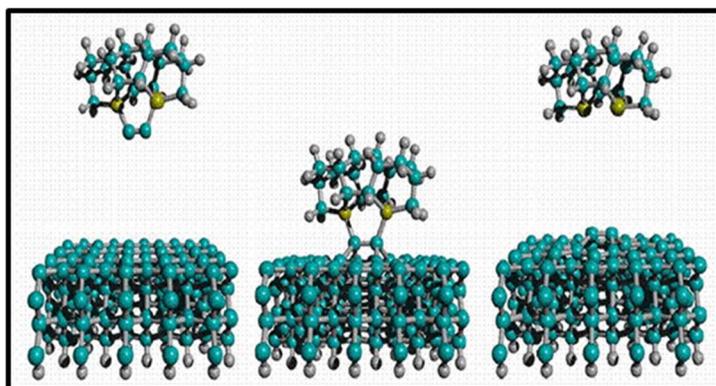


Figure 3: Basics formation of molecule in nanotechnology of nanotechnology (Source: 8)

C)Mechanosynthesis:

Mechanosynthesis is related to providing mechanical energy and producing chemical energy [12]. the chemical reaction is at a molecular level and effective. Therefore, in the construction industry, Mechanosynthesis is the most prominent nanotechnology that can be used due to the use of the different chemicals in the industry [11].

D) Molecular engineering:

Molecular engineering is related to producing devices of carbon fibre [10]. Such technology aims toward producing technology functional devices at the same time the goal is to produce lightweight devices. Thus Molecular engineering is a prominent branch of nanotechnology to be used in the construction industry.

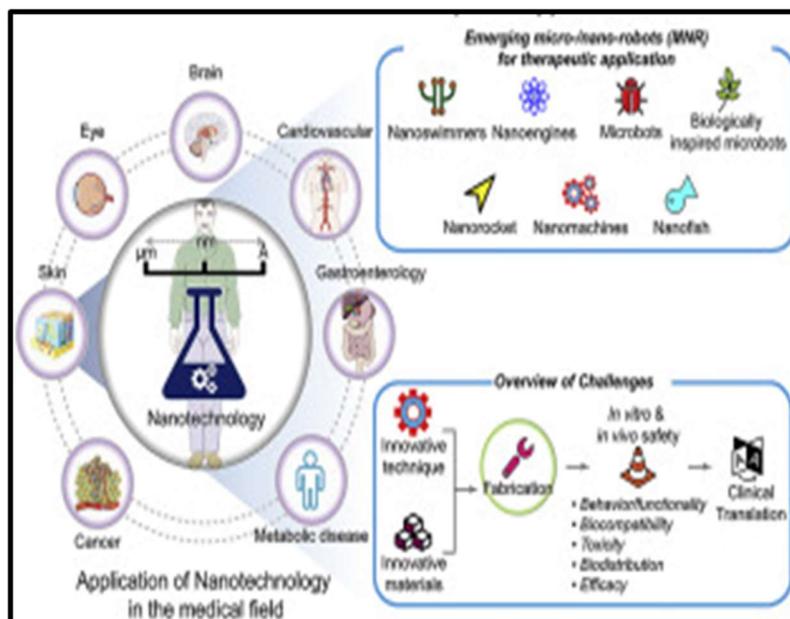


Figure 5: Basics use of nano-robotics (Source: 8)

V. BOTTOM-UP AND TOP-DOWN THEORY NANOTECHNOLOGY

The model of bottom-up and top-down are used in the time of building nanoparticles. The concept of synthesising nanobots is related to the process of synthesis [6].

A) Bottom-up

In the bottom-up method of synthesising nanoparticles the assembling process of the particles is done with chemical bonding or physical force thus from the basic unit a larger structure is formulated. The bottom-up technique is an important technology due to its strong fabrication.

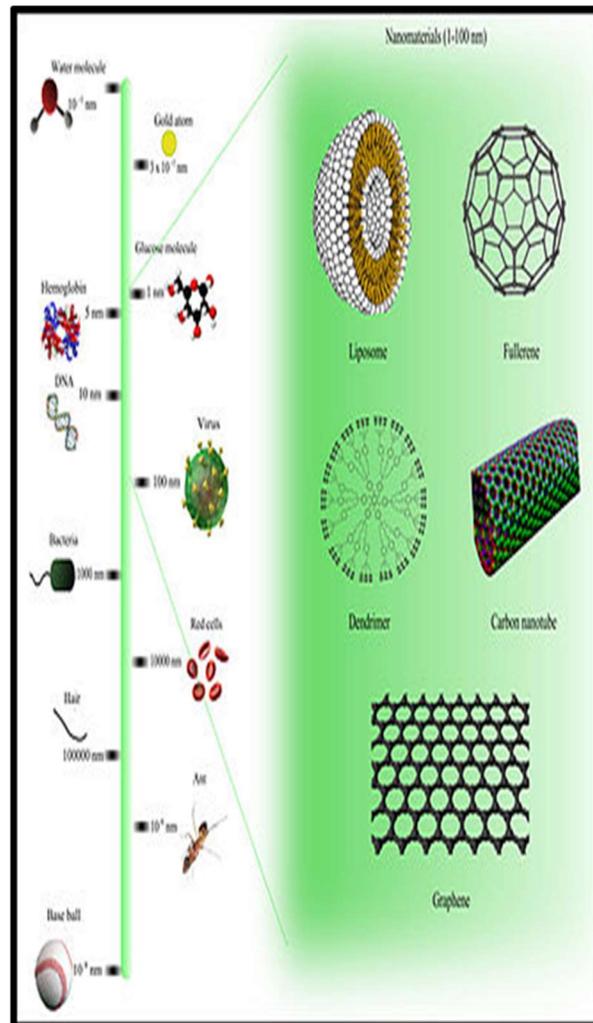


Figure 4: implication of nanotechnology (Source: 2)

B) Top-down

The top-down method is related to the breaking down of bulk material to form Nano sized particles. Top-down methods have different implications depending on the purpose. Therefore for construction, there are certain implications related to both the theories of nanofabrication [13].

| Material | Size range | Shape | Properties | Applicability |
|---|------------|-----------|---|--|
| Fullerene Carbon nanotubes | nm | Nanotubes | carbon nanomaterials in molecular electronics | Nanowire and biosensor for diagnosis |
| Poly(lactic acid) Poly(cyano)acrylates Polyethylenimine Block copolymers Polycaprolactone | 1-1000nm | Spherical | Biodegradable Biocompatible Smart material (external stimuli degradation pH, temperature...) | Drug/gene delivery |
| Gold nanoparticles | 3-100 nm | Spherical | electronic, optical, and thermal properties | Diagnostics and detection of biological molecules at low concentration |
| Magnetic nanoparticles | 3-100 nm | Spherical | Magnetic properties | Magnetic immunoassays, drug delivery, cell separation, purification, |

Figure 6: Different materials and their identification in nanotechnology (Source: 12)

VI. ADVANTAGES OF UTILISATION OF NANOTECHNOLOGY IN CONSTRUCTION

Nanotechnology is mainly part of science and engineering and its principle is to create and fabricate materials and tools at the nano-scale that is almost lower than 100 nanometers. It has been observed that the application of nanotechnology in the ground of construction has the ability to revolutionize an industry with the help of advanced materials and strategies for creating more powerful, stable, as well as more energy-efficient structures [1]. There are several advantages that can be found in the application of nanotechnology in construction, that are, increased material properties, enriched durability, enhanced energy efficiency, various self-cleaning surfaces and cost reduction.

Along with this, this process can increase the level of durability of the building materials by making them more unsusceptible to environmental aspects, including temperature change, UV radiation and moisture change [2]. However, this may lead to strong buildings that need less maintenance cost and lower repair costs.

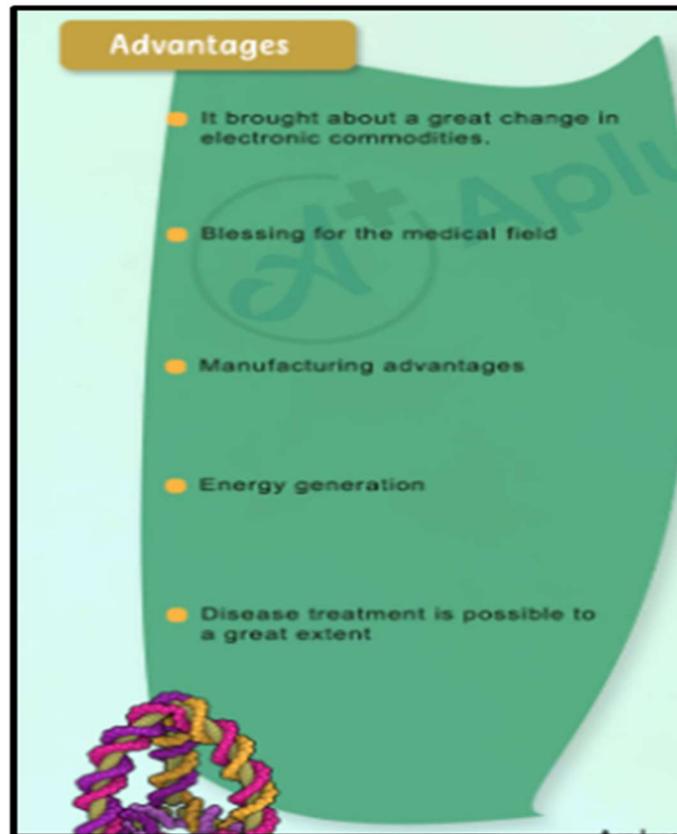


Figure 7: Benefits of Nanotechnology (Source: 5)

On the other hand, nanotechnology can be applied to design building materials that are energy efficient, like different insulation materials with greater insulating properties that help to block heat transfer at the time of allowing the light to pass through [3]. Moreover, this advanced technology can be used to develop self-cleaning surfaces for construction materials. This can minimize maintenance costs and enhance the building's appearance.

VII. LIMITATIONS OF USAGE OF NANOTECHNOLOGY IN THE CONSTRUCTION SECTOR

There are several potential drawbacks that can be found in the application of nanotechnology in the area of construction which are health and environmental issues, poor standardization, limited availability and high cost. The use of nanotechnology with nano-particles could create many health and environment-related issues when the particles are discharged into the environment at the time of the construction process [4]. However, it is important to conduct in-depth research on the issues

and take suitable measures for reducing them. It has been noted that, as the use of this technology is still a completely new field, there is always a chance of a lack of standardization and poor regulation in the industry [5]. This can result in inconsistency in the implementation, performance and quality of nanotechnology according to the building materials.

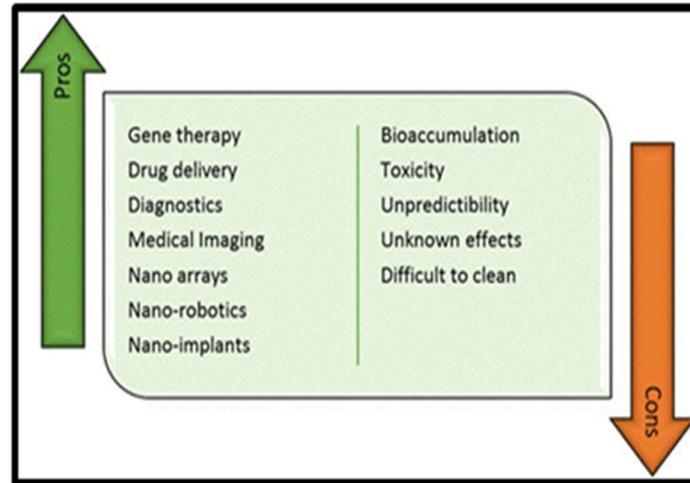


Figure 8: Limitation of usage of Nanotechnology (Source: 5)

Along with this, the growth and production of nanotechnology-oriented building materials can be pricey and that can make them cost-prohibitive for several building projects. This might limit the application of these particles and materials to high-end as well as specialized projects. Therefore, it can be deduced that careful analysis and testing are required to assure that these materials are completely safe, budget-friendly, and effective before they are adopted in the industry.

VII. PROBLEM STATEMENT

During the analysis, it was found that the implication of nano-particles is costly thus for the construction industry the implication is hindered. Similarly, it was seen that the implication of Nanotechnology is versatile however there is a lack of opportunity in the construction industry. Therefore, there is a huge opportunity in the construct construction industry for implementing nanotechnology. Similarly, it was seen that there is a problem regarding the implication of nano-bots due to the harsh condition of the construction sites. Moreover, the implementation of nano-bots is identified as a valuable implication of nanotechnology. However, other nanotechnology cannot be used in the construction industry.

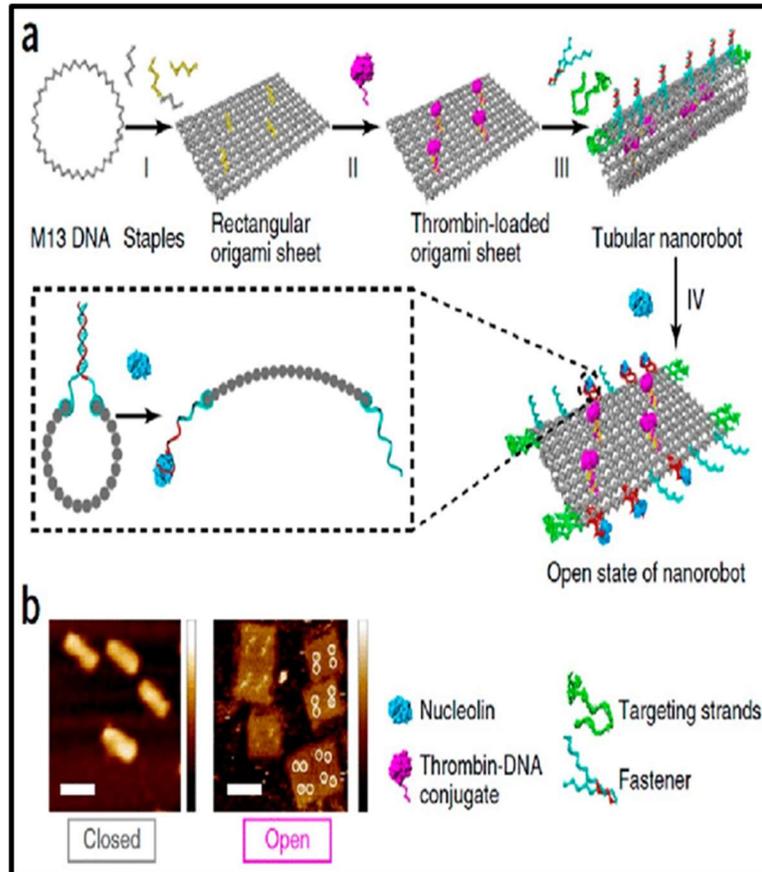


Figure 9: Nanorobotics in construction (Source: 5)

CONCLUSION

For the implication of nano-robots in the construction industry an overall discussion is presented in the study. In order to understand the implication of nano-bots in the construction industry define nanotechnology is described. At the same time, bottom-up and top-down theories are explained in order to produce a better result for the study. It was found that there are different parables regarding the implication of nanotechnology which hinders the implication. Similarly, advantages and disadvantages are described in the study that helped to understand different factors related to nanotechnology. Therefore, a complete study is done in a systematic way.

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