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The use of innovative materials in innovative architectural applications. Combining forces for high performance structures. [★]

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Abstract

Nanotechnology has already revolutionized many industrial fields. The advantages through implementation of nanotechnology in architecture are multidimensional as they are not limited to sustainability and energy efficiency of buildings. The era of Nanoarchitecture has emerged, providing new possibilities that affect both architectural design and architectural applications. Flexibility and dynamics of forms and aesthetics, adaptation in external and internal requirements, protection of quality in living conditions and ad hoc control of microclimate are now feasible. Structures adopt mechanisms from nature and begin to mimic living organisms. Features such as air-purifying, self-cleaning, temperature regulation, self-healing, energy producing/saving as well as fireproofing, solar protection and insulation can be effectively combined and create high-performance buildings with extended life-cycles. Nanomaterials, i.e. carbon nanotubes, nanofibers, nanoscale truss etc, give new qualities in structural forms and their carrying capacity. This study examines the above mentioned potential combinations that can lead to an innovative intelligent system of an outer “epidermis” that can function as a structural feature of both main and secondary purpose. In this paper an overview of recent developments in Nanoarchitecture is given, together with the interesting potentials of materials which give life to the conceptual frame of contemporary architecture.

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1. Introduction

One of the basic human activities from the beginning of civilization was the creation of a shelter. Basic natural materials found in proximity were the first components of human structures. Those conventional, traditional, per se, materials are still in use in architecture creation and construction. The unique characteristic of human nature has always been the ability not only to adapt to the environment but also to adjust environment to their needs. In accordance to the latter, technology has become the infinite manipulation tool. Nanotechnology in particular is a rapidly developing field with numerous current and potential applications in various other fields. Many possibilities that nanotechnology can offer, if combined together, they can promote architectural creation and project realization. Reduced time in implementing architectural plans diminished negative environmental impacts through low emissions from materials production, as well as increased energy efficiency of buildings -that can produce sustainable energy and even perform air purification and water filtering. Even increased positive performance of structures, due to self-assembly and self-repairing features, are some of the objectives to be met. Smart materials and new techniques have already been used, i.e. self-cleaning and air-purifying surfaces, insulating and anti-microbial coatings, sun radiation protection and fireproof membranes. Further ahead, as research is progressing in bio- and nanotechnology, we could combine new features in order to develop systems that mimic nature in the field of construction. The concept of our research represents an effort of combing these new dynamics of nanotechnology in order to create an intelligent system of external bearing structure that can perform multiple functions. A system that will be able to carry structural load and at the same time produce energy and filter the air, one that will have the capacity to transform according to external climatic conditions in order to regulate internal climate and that will have aesthetic dynamics through colour shifting and transparency switching. All this approach is part of the conceptual framework of a dissertation study that aims at concluding in implementing an experimental model system.

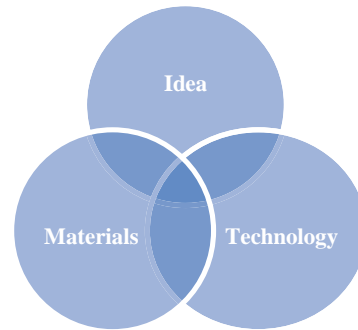


Figure 1. A structure is a result that comes from combining three forces.

2. Technology in Architecture

A positive effect of technology in architecture is the computer aided design and the creation of 3D models (CAD, modelling, 3D rendering, 3D printing). The next step is realized by the introduction of genetic architecture in combination with nanotechnology. Computer design techniques strengthen the interdisciplinary relationship between architecture and other sciences. Also, new building techniques and construction methods have rendered project implementation easier and more efficient. New organic forms inspired by nature can now be digitally produced and constructed.

2.1. Nanotechnology

Nanotechnology is the design, characterization, production and application of forms, mechanisms and systems through controlled manipulation of shapes and dimensions at nanoscale that produces forms and systems with at least one improved or new property [1].

The development of nanomaterials will bring benefits to society [2]:

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