REVIEW ARTICLE

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A Review on Nanotechnology Applications in Electric Components

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ABSTRACT: Nano science and nanotechnology innovations have shown incredible results in current era. It increases their applications in various fields such as Engineering, Physics, Chemistry and Biology. The development in nanotechnology has replaced conventional concepts. The remarkable performance of nanotechnology caught the eye of electrical engineers to make reliable and efficient electrical components. Electrical engineers using Nano-concept and make Nano-structured value-added products with high superior qualities. This review climaxes the concept of nanotechnology in various electrical components such as in nanowires, insulators, transformers and dielectric fluids with possible future prospects.

Keywords: Nanotechnology; nanowires; Nano fluids; insulators, transformers

1. Introduction

Nanotechnology is now a broad field of science and technology which deals with controlling of matter at a Nano scale. It is an interdisciplinary field contributing in physics, electric and mechanical engineering, chemistry and biosciences. Fundamentally, nanotechnology affects these categories and play role in these areas application [1]. Nanotechnology, basically use technologies which produce materials in range of 1-100 nm. This quality of nanoparticles delivers a large surface area per unit mass than those which are not in nano-size [2, 3]. For the creation of nano-structured materials, only two basic approaches are used. The approaches which are applied are top-down technique and bottom-up technique [4, 5]. The top-down approach, which leads physicists and engineers to manipulate progressively smaller pieces of matter by photolithography, Electron-beam lithography, X-ray lithography and related techniques, has operated in an outstanding way up until now [6]. It is becoming increasingly apparent, for example, that miniaturization in computer technology, which relies on silicon-based chips, is rapidly approaching the upper limits of its capabilities [7, 8]. But it is very large on the scale of atoms and molecules. Therefore, “there is plenty of room at the bottom” for further miniaturization. An alternative and most promising strategy to exploit science and technology at the nanometer scale is offered by the bottom-up approach, which starts from nano- or sub Nano-scale objects (namely, atoms or molecules) to build up nanostructures. The bottom-up approach is largely the realm of Nano science and nanotechnology. This is the reason why chemists, being able to manipulate atoms and molecules, are in the ideal position to contribute to the development of Nano science and nanotechnology [9, 10]. The top-down method is applied to process just as in the semiconductor process, whereas the bottom-up method is applied to integrate molecules or atoms into nano-scale materials just as a living organism synthesizes DNA and proteins, and integrates them into a cell, and further, into a body (Figure 1) [5, 11]. Due to vast applications of nanotechnology in various fields, nanoscience plays a critical role in electronics industry nowadays. Continuously the number of transistors has been reduced over period of time. Modern techniques integrated circuits incorporate transistors with feature as small as 32 nm [12]. Today, innovations in nanotechnology are present in vast area of electrical engineering. It plays role in electrical power engineering such as ultra-low resistivity conductors, dielectric nano fluids, nanofillers for insulating materials, monitoring and diagnosis (M & D) systems, nanostructured coatings and others [13, 14].

Nanotechnology displays the possible significant innovations which will revolutionize the energy sectors [15].

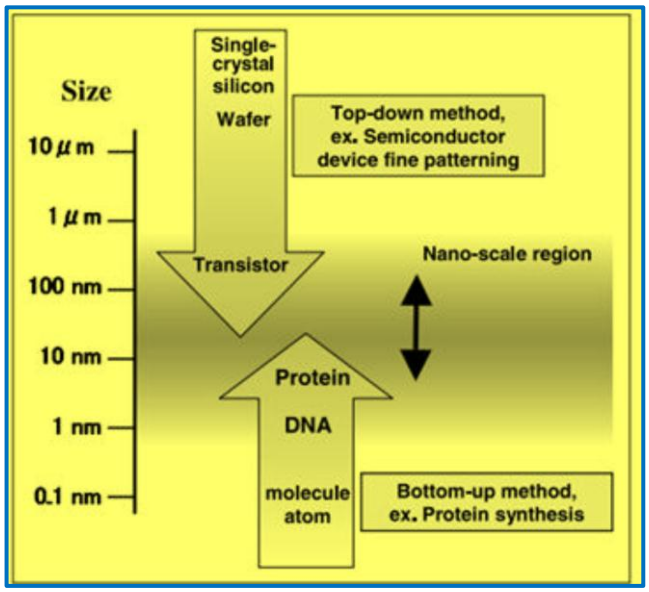

Figure 1. Two basic approaches

2. Semiconductor Nanowires

Researchers are trying and creating wires which possess on carbon nanotubes and it is expected that these wires could lower resistance, which will reduce the transmission power loss. The semiconductor nanowires (NWs) nowadays presented a unique significance and are assumed to be representing critical role in future electronics [16]. Research in the area of semiconductor NWs over the past periods, has aided to redesign crystal atomic-scale assemblies and expose novel physical understanding at the nanometer scale. In the next generation of photonic and electronic devices, compound semiconductor nanowires have been recognized as dominant components. This is particularly beneficial for efficient collection of photo generated carriers when core and shell segments are engineered to be thinner than minority carrier diffusion lengths. Nanowires (NWs) are more conductive to heterogeneous mixed solutions, owing to the nature of the NW geometry to accommodate heteroepitaxially-induced strain by relaxation along the NW free surface. This advantage successfully raises the critical width of lattice-mismatched NW crystals in comparison to epi-layers having a purely planar geometry. Consequently, NW array-based constructions are effective for multi-junction PVs, insofar as high-efficiency devices trusting on the monolithic integration of III-V materials with Si technology have been envisioned. Nowadays, Semiconductor NWs are considered as one of the most influential platforms available in nanoscience. It encouraged scientist to design possible structures with the help of *ab-initio* [17].

3. Nano Fluids-Based Dielectric Fluid Transformer

The transformer is considered one of the key components of the electricity network which distributed and transmitted electricity. The fault in any part of this component can leads to interruption of power system [18, 19].

The dielectric fluids present in transformer is also the main element. It performs two functions, insulating and cooling. These fluids acts like as blood in human body [20].

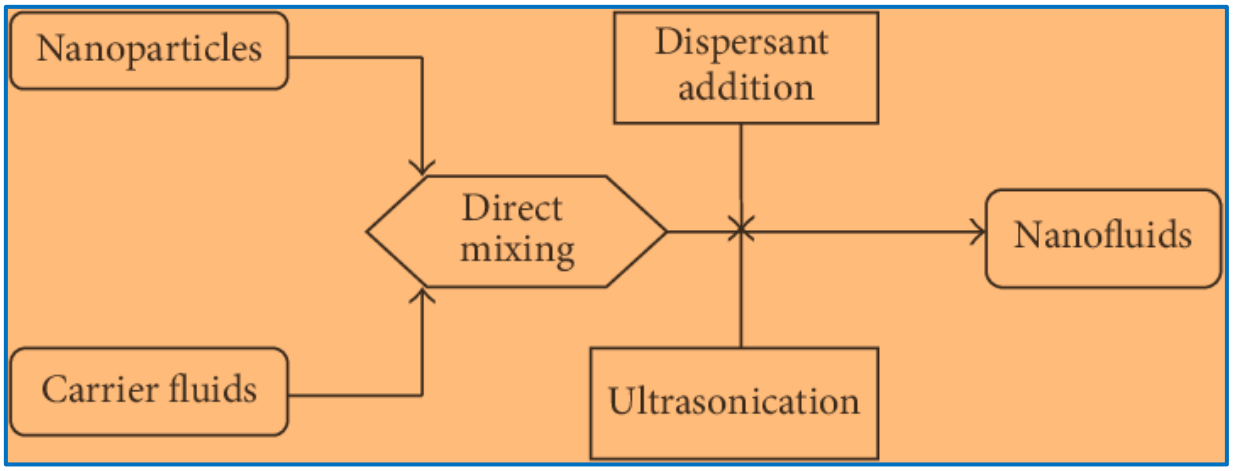

Figure 2. Preparation method of nano-fluids

4. Nanotechnology in High Voltage Insulators

One of the greatest important developments in the history of ceramics was the creation of a vitrified, translucent porcelain body [30]. Porcelain has been extensively used in decorative ware, sanitary ware, medicine and dentistry, dinnerware and electrical insulators. The cheap and easy availability of raw materials and the simplicity for processing a body have made porcelain manufacturing or pottery-making a principal business since the prehistoric times [31]. Definition of Porcelain is the traditional ceramics which are made from raw materials possess on clay, followed by heating [32]. This type of Porcelain is extensively studied for application of advanced engineering [33]. Still it is challenging to understand the relation of raw material and of its science.

Trixie Porcelain is one of the major popular materials. This is used historically for both high and low voltage insulators. Trixie has the same chemical composition as of porcelain which is designed by a combination of three materials. The three materials are feldspar, clay and alumina or silica. Distinct characteristics are given each raw material to porcelain [34].

Nowadays, nanotechnology innovations have Enhanced the property of porcelain insulators. These interesting and extraordinary investigations results carried out in various ceramics materials (Figure 3) and porcelain system for traditional and dental applications [35, 36].

One investigation carried out on nano-sized TiO_2 photo-catalyst to improve the performance of the ceramics insulator. For preparation of TiO_2 coating insulator some amount of TiO_2 was sprayed on ceramics insulator and then it is followed by calcination. The results revealed that TiO_2 coated insulators has excellent photo-induces performance and have enhanced self-cleaning ability in pollution as compared to uncoated insulators [37]. Hence, it is proved that nanoparticles coated insulators establishing a promising era to prevent insulator from heavy pollution and enhance electrical properties.

5. Nano Applications in Electric Transformer

Electrical transformer carries variety of potential materials like aluminum and copper conductors for winding. It comprises silicon-steel and amorphous metal for magnetic cores, steel for inner tank and structures, external and internal coating for the tank etc, polymeric gaskets etc.

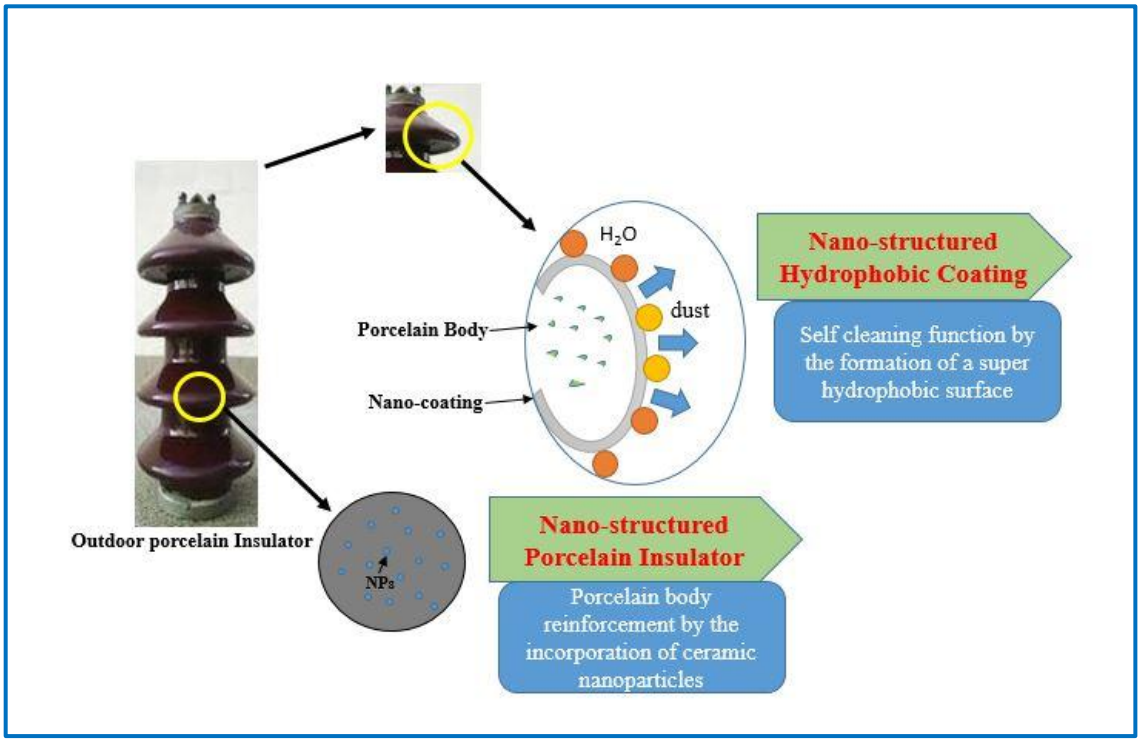

Figure 3. Schematic of the main nanotechnology concepts for outdoor insulators

Aluminum and copper has been used from long time for winding conductor of electrical transformers. Current developments focused to create new material with high efficiency, high conductivity and better mechanical performance. Copper nanotube has been studied from long time as alternative to copper in electric machine. It is used because of its excellent and unique properties [38-42]. In the year of successfully developed a new Carbon nano-tube (CNT) based technology for wires and coils to replace copper wire conductor in a small electric transformer [43, 44]. Researchers stated that CNTs based metallic conductors could scale up the manufacturing capacity of electric transformers. Recently electrical industries are focusing on nanostructured steel to make more potent materials using nanotechnology applications for transformer. These technologies specify to make steel for multipurpose properties [45]. Novel strategies are using to fabricate microstructure material at Nano-scale level. Recently, for the first time Tata steel with collaboration of Cambridge University developed a steel based new super bainite alloy. For the enhancement of magnetic presentation of transformer core, nanotechnology could play a vital role. The tank of electric transformers is painted for the purpose to protect them from corrosion. Nanotechnology applications attained a great attention of researcher's to protect the tank from corrosion and degradation. Nanoparticles coating on tank recently showed remarkable growth. These application of nanoparticles coating exhibits attractive characteristics as compared to traditional products [46]. From these all it is concluded that nanotechnology strategies could enhance the quality and performance of electric transformer materials.

6. Conclusion and Future Perspectives

It is concluded from all above scenario that nanotechnology initiatives completely revolutionize the research and development in material sciences by bringing new concepts in industrial sectors. The advantage has been taken by energy sectors from this technology where they use Nano-concepts in various products and components such as transformers, insulators, dielectric Nano fluids and semiconductor nanowires. Nanotechnology added advance innovations which improve the reliability and characteristics of materials and products which alternate the conventional methods.

Nanoparticles coating are applying in insulators, transformers tank and in nanowires to make them hydrophobic and to protect them from heavy pollution degradation and corrosion respectively. Institutes are encouraged to collaborate with electrical industries to make more viable products. It is predicted that both academic and industrial Research and development products will grow in the coming years. The researchers forecast that Nano-structured electric components will be ready in coming 5 to 10 years which will show great mechanical and electrical performances, weight and size, optimized geometry and self-cleaning surface for pollutants. Furthermore, a strong link is dire needed between academia and industries to use nanotechnology concepts for the creation of superior Nano-structured components.

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