Nanoparticels And Its Energy Transmissions

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Abstract- *Nanotechnologies can improve energy transmission by enhancing the current technologies and encouraging more innovation. This can also affect how we assess the environmental impacts of using right-of-way (ROW) for transmission lines. This document explains what nanotechnology is, how it differs from traditional methods and materials, and how it can reduce the negative effects of ROW. Moreover, the document discusses the possible outcomes of nanotechnology on environmental, safety, and health issues.*

Keywords- NANOMATERIALS, NANOSCALE, CARBON NANOTUBE(CNT), NANOSYSTEMS.

I. INTRODUCTION

Nanotechnology, despite the absence of widely agreed definitions, is generally understood to be the new structure, material, system, catalyst, and device creation that results from the manipulation of matter at the atomic size, exhibiting novel phenomena and features. At the nanoscale level (e.g., 1–100 nm; a nanometre [nm] is one billionth of a metre, or the length of 10 atoms), some materials show particular physicochemical, chemical, and biological properties. The unique qualities of the materials (like high strength) and miniaturization (like sensors) both provide potential benefits.

Technologies that are more effective and ecologically friendly than those now in use might be introduced thanks to nanotechnology. Within the next 10 to 15 years, nanoproducts are expected to have a $1 trillion worldwide industry, according to economists [1]. Commercially accessible nanotechnology-based products at the moment include consumer items like wrinkle-free clothes, industrial measurement and sensing equipment, and medicinal systems. Numerous industries, including energy, agriculture, manufacturing, transportation, medical, computer, and electronics, are the focus of ongoing study. Developments in nanotechnology may make it easier to create materials at the molecular level, which might result in the creation of self-repairing structures, new kinds of computers, and really intelligent systems. However, basic research on nanoparticle measurement, behaviour, characterisation, characteristics, manufacturing methods, and environmental dangers is crucial before these applications become a reality.

1.1 NANOPARTICLES WITH THE POTENTIAL TO IMPACT ENERGY TRANSMISSION SYSTEM DEVELOPMENT

Technologies that are more effective and ecologically friendly than those now in use might be introduced thanks to nanotechnology. Within the next 10 to 15 years, nanoproducts are expected to have a $1 trillion worldwide industry, according to economists [1]. Commercially accessible nanotechnology-based products at the moment include consumer items like wrinkle-free clothes, industrial measurement and sensing equipment, and medicinal systems. Numerous industries, including energy, agriculture, manufacturing, transportation, medical, computer, and electronics, are the focus of ongoing study. Developments in nanotechnology may make it easier to create materials at the molecular level, which might result in the creation of self-repairing structures, new kinds of computers, and really intelligent systems. However, basic research on nanoparticle measurement, behaviour, characterisation, characteristics, manufacturing methods, and environmental dangers is crucial before these applications become a reality.arranged in a parallel configuration, may support more than 100 trillion conductors. The cable could carry 100 million amps of electricity if every tube carried just one microamp, or 2% of its total capacity. The creation of this kind of cable, known as the "armchair quantum wire," is one of the main goals of current studies [3].

Examples of nanoparticles with the potential to impact the development of energy transmission systems include the following

- Carbon Nanotube (CNT): A kind of fullerene (made of only carbon) molecule that has a tube-like shape from carbon atoms joining together. CNTs are usually light, strong, and tough. Some CNTs can carry electricity much better than steel or copper. They are sold in large amounts for industrial uses, but their price can be up to $200,000 per pound.

- Buckyball Fullerene: Nano-shapes that look like balls made of carbon atoms, which can have other atoms on or inside them. These shapes are used for mechanical and semiconductor purposes.

- Nanodots or Quantum Dots: Tiny crystals made of semiconductors that have electrical and optical features that can make lighting and solar energy more efficient.

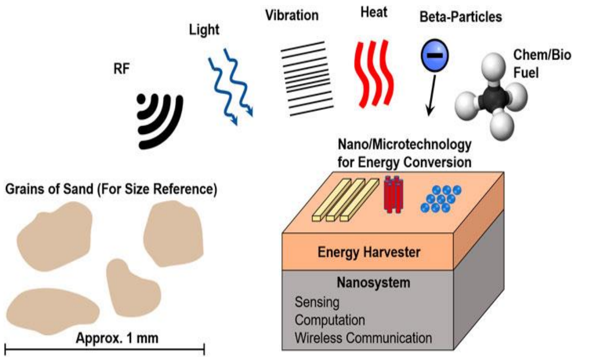

Figure 1.1.1: Illustration of an example nano system and various modalities for energy harvesting.

II. ENERGY HARVESTING MODALITIES

Table 2.1:

Energy source	Conversion devices	Outlook
Radio-frequency	Antenna	Low loss power transfer, efficient at centimeter scale, antenna efficiency drops steeply sub-mm
Optical	Photovoltaic cell	Efficient and highly scalable, requires line of site access to light source
Mechanical	Piezoelectric, triboelectric	Wide range of source availability over range of frequencies, high efficiency for biological systems, challenges in scaling mechanical structures at sub-mm scale
Thermal	Thermoelectric, thermophotovoltaic, thermoradiative	Waste heat available in many situations, thermoelectric behavior scalable but requires temperature gradient, challenges in scaling radiative approaches such as thermophotovoltaic
Nuclear	Betavoltaic	Scalable with long-term stable source, challenges in ensuring health and safety and scaling packaging/ shielding
Chemical, biological	Chemical and microbial fuel cells	Can utilize energy sources in specialized environments, drawbacks of long time constant or startup time and scaling reactor chambers to sub-mm dimensions

2.1 Radio-Frequency

Energy can be harvested from radio-frequency (RF) sources that come from the surroundings or from deliberate radiation. RF technology is the most widely used method in the field of Internet of Things (IoT) technology. Devices like RFID tags and readers have been common for years, with various uses from credit cards and card readers to health and safety tracking devices [4]. These RFID applications usually rely on inductive coupling for small chips, but they can also connect to coil antennas that have sizes of centimetres or more. The link's efficiency depends on factors like coil shape, coil quality factor, frequency, and the gap between the transmitter and receiver. But efficiency drops a lot when the size goes down to near 1 mm [Rabaey et al., 2011]. To make it smaller to the micrometre and nanometre level and still have good efficiency, the frequency has to go up or new ways of making very small antennas have to be found. Going to higher frequencies may work for some systems that are close together, but the losses in the air and the efficiency of the high-frequency electronics in nano-systems have to be taken into account. Metamaterials can be used to get high efficiency at very small sizes and to make the direction more specific.

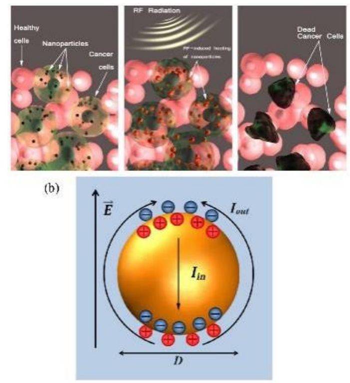

Figure 2.1.1: Radio Frequency Technique

2.2 Optical

Light is a good form of energy for making devices smaller to the micrometre and nanometre level. Energy can be harvested easily using photovoltaic (PV) cells that work for outdoor or indoor lighting, or other light sources. PV cells can give an operating voltage of about 0.5 V, depending on the kind of light source and PV cell technology. This voltage can be made higher by connecting cells in series or using tandem cell designs. Making devices smaller than 1 mm may lower conversion efficiency because of non-radioactive recombination effects at the edges of semiconductors. To get high energy conversion efficiency, semiconductor surfaces have to be passivated. At higher power density, sensors that do not need wires or batteries have been shown to work at sizes of 100 µm.

Optical antennas, which work on the nanometre level and can have efficiencies over 60%, are another way to harvest optical energy besides the PV effect. The idea of using antennas to couple light can also be combined with photovoltaics by using plasmons. Plasmon coupling to PV cells makes optical absorption better and allows optical coupling at near and very small sizes.

Optical energy harvesting has some challenges, such as needing a clear path between the system and the light source (e.g., putting sensors in concrete may not work well). The type and direction of the light source affect how well the photovoltaic cells can harvest energy. The light levels can change a lot, so the system needs to store energy and have a circuit that can detect the light level and adjust thepower accordingly.

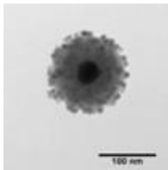

Figure 2.2.1: Optical Energy Photovoltaic

2.3 Mechanical

Piezoelectric devices can turn mechanical energy from random vibrations or moving things into electricity. These energy collectors are used a lot in things like sensors for monitoring infrastructure, tire pressure, and heartbeats. Usually, they use micro-electro-mechanical systems technology with cantilevers or membranes that are bigger than a millimetre, but new research is looking at making them smaller with nano-wire technologies. Piezoelectric nanogenerators, which use single nanowires or groups of them, have shown to work well, and they could make it possible to power nano systems.

Another way to make electricity from mechanical systems is to use the triboelectric effect and electrostatic induction. These devices work by making contact and separating, sliding sideways, and using single electrodes. They used to be bigger (centimetre size) and the word "nanogenerator" meant making electricity by moving charges rather than the device's size. In theory, they can be made smaller to less than a millimetre, but they need good design of the layers that do not conduct electricity and the space between the electrodes. New improvements in making more charge density make triboelectric nanogenerators hopeful, but they have to deal with the high voltages from static electricity.

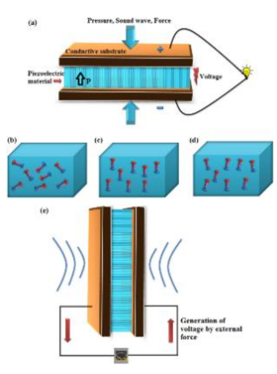

Figure 2.3.1: Piezoelectric Sensor

2.4 Thermal

Some ways to use waste heat are thermometric, thermophotovoltaic, and thermoradiative methods. The thermometric method uses the See Beck effect, which needs a difference in temperature inside the device. Thin films, superlattices, and quantum dots made of materials that can turn heat into electricity are good for making power at small sizes, as shown in tiny systems with a volume of 1 mm3, that can get 775 µW/mm3 from a temperature difference of 9K outside.

Thermophotovoltaic and thermoradiative methods use radiative transfer, which means they get or give out radiation. How well these devices work depends on how hot the heat source is and what material they use to match the energy gap with the heat radiator's emission. Small thermophotovoltaic harvesters that use tiny heat reactors have been shown to work on a 1 cm2 area, giving 344 MW of power. But making them smaller to less than a millimetre is very hard, because they need either very small micro-reactors or to be very close to a hot heat source.

Thermoradiative method is the opposite of thermophotovoltaic, where the device gives out heat as radiation to a cooler place to make electricity. Thermoradiative harvesting is not well developed yet and has few experiments. In theory, this method can be made very small, and it can be used in special cases where systems touch a lot of heat or are in a place with little radiation.

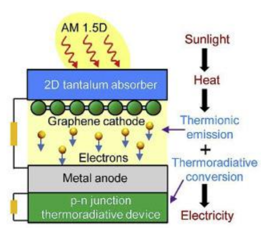

Figure 2.4.1: Thermoradiative Analysis

2.5 Nuclear

Small-scale nuclear energy can make electricity in a semiconductor junction by taking in beta particles from radioactive sources. These devices are called beta voltaic cells or batteries and they need a radioactive source inside them, like tritium or nickel-63. Semiconductor junctions use different semiconductors, such as silicon, silicon carbide, and gallium nitride. Beta voltaic technology is getting better in the area of nanoscience, using devices made of nanowires. Beta voltaic systems can give steady power for a long time, about 10 years or more, making them good for things like medical devices that go inside the body and systems that need a power source that cannot be tampered with [9]. The power density for beta voltaic systems is very low, so they are good for many systems that do not need much power. The main worries about beta voltaic systems are the health and safety risks of using radioactive materials, and the need for proper protection and storage within devices. Making beta voltaic devices smaller to less than a millimetre is probably limited by these packaging needs to make sure they are safe and healthy.

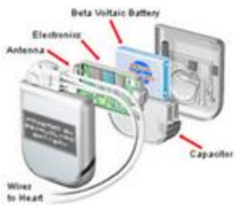

Figure 2.5.1: Beta-Voltaic Analysis

2.6 Chemical and Biological

Small fuel cells can use chemical and biological sources to make electricity in very small systems. Proton exchange membrane fuel cells usually use methanol and ethanol as fuels, and devices that are as big as centimetres have been made. The microreactors in these systems are usually made using MEMS technology, but making them smaller may be hard because of the problems of controlling gas flow and putting in a fuel cartridge.

Microbial fuel cells use rotting organic matter and tiny living things that can give out electrons to make electricity. This is good for making very small environmental systems work from far away, using biological materials that are already in the soil, sediment, or rotting plants [12]. One good example of microbial fuel cells is in biosensors that can check the quality of wastewater in real time. Like chemical fuel cells, microbial fuel cells need careful control over how much fuel they get. Another thing to think about with microbial fuel cells is the time it takes for the tiny living things to grow, which is usually a fewdays

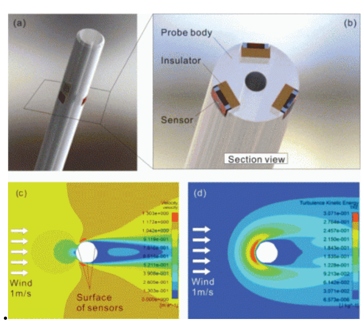

Figure2.6.1: MEMS Analysis

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