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RESEARCH PAPER

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A Review on Role of Nanotechnology to Combat Changing Climate

S.H.A. Kazmi, *T.S. Naqvi, Syed Rais Haider and Syed Nazeer Haider Zaidi

Department of Botany, Shia P.G. College, Lucknow, U.P., India

***Department of Zoology, Shia P.G. College, Lucknow, U.P., India**

ABSTRACT

One of the greatest current environmental concerns in the world is climate change which is primarily caused due to burning of fossil fuels, such as oil and coal, and anthropogenic activities such as overexploitation of natural resources, environmental pollution, agriculture and deforestation. Climate change can have a serious impact on promoting an increase in ocean temperature and ocean acidity, loss of species, diminished freshwater resources, extreme weather events, crop failures and rising sea levels. The adverse effect of climate change is on Sustainable Development which can be felt by future generations. Nanotechnology is flourishing as one of the most advanced technology for mitigating and combating climate change. Various Research and analysis have illustrated nanotechnology may have a major role to play in responding to climate change. Nanotechnology has applications such as the hydrogen-based economy, solar power technology or next-generation batteries which can significantly contribute to energy saving and greenhouse gas reduction. The paper highlights the impact of climate change and the potential advantages of nanotechnology towards climate change and the new challenges they may raise.

Keywords: Natural Resources, Environmental Pollution, Deforestation, Nanotechnology, Climate Change.

INTRODUCTION

Since the Industrial Revolution (i.e., 1750), an increase in greenhouse gas concentration and their marked rate of change are largely attributable to human activities. Humans have contributed to climate change through the emissions of GHGs and aerosols, and through changes in land use, resulting in a rise in global temperatures. Increases in global temperatures may have different impacts, such as an increase in storms, floods, droughts, and sea levels, and the decline of ice sheets, sea ice, and glaciers. Reducing Greenhouse Gas (GHG) is the key to mitigating and reducing the

effects of climate change. Adapting to these effects is also an important component of the response to climate change (Ghosal and Thomas, 2018).
Most countries face serious challenges from climate change. Countries use several assessment models, tools and methodologies as well as various scenarios, including those provided by the IPCC (IPCC 2000), to help provide an assessment of the future impacts of climate change. Nanotechnology is flourishing as one of the most advanced technology for mitigating and combating climate change. As climate change remains a top concern, it could also help manufacturers reduce their environmental impact by saving raw materials, energy, and water, while reducing greenhouse gases and hazardous wastes the application of nanotechnology in climate change may have a major role to play towards reducing greenhouse gas emissions when it is incorporated into larger systems, such as hydrogen fuel technology, solar power technology or next-generation lithium-ion batteries technology.

Climate Change
Climate change is a global crisis, and certain regions are already feeling the devastating consequences that come with it. Climate change refers to the shift of weather patterns due to an increase of greenhouse gas (carbon dioxide, nitrogen dioxide and methane) emissions in the earth's atmosphere from burning fossil fuels. The increase in these greenhouse gases has caused a rise in the amount of heat resulting in climate change. Climate change can have a serious impact on promoting an increase in ocean temperature and ocean acidity, loss of species, diminished freshwater resources, extreme weather events, crop failures and rising sea levels. As a result of global warming, the type, frequency and intensity of extreme events, such as tropical cyclones (including hurricanes and typhoons), floods, droughts and heavy precipitation events, are expected to rise even with relatively small average temperature increases. Climate change will result in drastic environmental and socio-economic impacts. Changes in the related sectors, including water resources, agriculture and food security, human health, terrestrial ecosystems and biodiversity and coastal zones pose a huge impact economy, culture, and well-being of a community. Various research and evidence have illustrated that climate change has an impact on economic growth (Webersik et al., 2008).
Information regarding the climate data(temperature, rainfall and the frequency of extreme events), and non-climatic data(current situation on the ground for different sectors including water resources, agriculture and food security, human health, terrestrial ecosystems and biodiversity, and coastal zones) should be assessed for the evaluation of the impacts and vulnerability to climate change and subsequently working on the needs.

Nanotechnology and Climate Change
Nanotechnology
The term "nano" is derived from ancient Greek which means dwarf. It is a billionth of a meter. Nanoparticles are of the dimension of about 1 to 100 nanometers. Because of this dimensional range, nanoparticles and structures get remarkable properties and nanotechnology deals with research and analysis of these properties also. Nanotechnology deals with the physical and chemical characteristics of molecular-scale structures, and they can be united to form larger structures for human use. The arrangement of the atom and molecule helps to determine the properties of the material. Nanotechnology is a multidisciplinary field of science and engineering which can operate functional materials, devices and systems at an atomic or molecular level. This is the most promising technology in many areas in the 21st century, such as in medicine, energy, climate change, and so forth (Rajput, 2017).

Scope of Nanotechnology in India
Nanotechnology carries enormous potential for India and a multi-pronged approach will build it fully leveraged. Since the early 2000s, the government of India has been playing a pioneering role in promoting nanotechnology R & D. A Mission on Nano Science and Technology (Nano Mission) was launched on 3 May 2007, by the DST to assist, encourage and develop all aspects of nanoscience and nanotechnology which can benefit the country. Nano Science and Technology (Nano Mission) in its Phase-II (2012-2017) at a total cost of Rs. 650 crore focuses on product development and commercialization for markets and consumers. The evolution of Nanoscience and technology in India has great potential to assist the country towards societal challenges such as the provision of drinking water, healthcare, etc., and simultaneously achieve economic gains through growth in the nanotech-

based industrial sector. Funding should be increased and long term funding that can help incoherent research programs with the high-impact outcome is required. Various research centers throughout India must corporate so that the collective efforts can help to improve the results. As nanotechnology is an emerging technology and India has ample skilled workforce, India can target to become a global leader in nanotechnology (Ahmed et al., 2019).

According to the reports BRICS (Brazil, Russia, India, China and South Africa association countries are the largest emitters of greenhouse gases(approximately 43.6% of the world total). So all these countries are aiming to use nanotechnology for the development of the country. Due to poverty and a lack of resources to reduce greenhouse gas the developing countries are being affected the most.

An International Conference on Nano Science and Technology in 2010 itself, Prof. CNR Rao, Nano Mission Council Chairman, said that 'as Indian industries are coming with various nanotechnological products including water filters, biomedical products, chemicals, cosmetics and paints, we are in the process of forming a regulatory body for the nanotechnology to regulate the products for the safety and benefit of the society' (Business Standard 2010).

Nanotechnology to Combat Climate Change

Researchers and policy makers admit that climate change is the most significant environmental, economic and security threat faced by mankind. To date, nanotechnology has applications in hydrogen storage and the development of efficient hydrogen-powered vehicles, enhanced and cheaper photovoltaics or solar power technology, the generation of new emerging batteries and supercapacitors and fuel efficiency.

Nanotechnology towards Hydrogen Economy

Nanotechnology plays a vital role in holding back the hydrogen economy: generation of hydrogen by making use of renewable energy sources, and safe storage and distribution of hydrogen around the world. The most significant application of nanotechnology in the hydrogen economy is in the development of hydrogen fuel cells. Photocatalytic generation of hydrogen from water and storage of hydrogen with the help of novel nanomaterials perhaps form the basis of viable distribution infrastructure, effectively permitting the vehicles and local combined heat and power (CHP) systems to move on solar energy, stored as clean and efficient hydrogen fuel (Khan et al., 2012).

The fuel cell is a device that converts fuel directly into electricity without combustion and thus is highly efficient, clean and quiet. It is a very favourable renewable energy application as it does not create any direct pollution and has no obstruction as regards thermal efficiency. The efficiency of the fuel cell can be improved with the help of nanotechnology. Nanoparticles increase the surface area to make the reaction more effective and to improve the performance of fuel cells. A carbon nano tube which is an allotrope of carbon with a cylindrical nanostructure helps to enter the hydrogen into the fuel cell. Thus making hydrogen storage easier. Scientists at Lawrence Berkley National Laboratory in 2011 developed a composite material formed of magnesium nanoparticles which were embedded in a flexible organic polymer matrix. The material formed has the potential of selectively absorbing hydrogen gas, safely storing it at high densities as magnesium hydride, and releasing it when needed. Scientists and Researchers at Indiana University have created modified enzyme encapsulated by a protein shell that effectively catalyzes the formation of hydrogen and also used as a fuel cell catalyst.

Researchers at Rensselaer Polytechnic Institute developed a method for manufacturing and using graphene, an atom-thick sheet of carbon atoms arranged like a nanoscale chain-link fence for safely storing hydrogen. The method is inexpensive and easy to produce.

These techniques have the ability to improve hydrogen production and, consequently, of making hydrogen a future energy carrier in the hydrogen economy. However, the economics of these technologies have to be evaluated to represent economic improvement. Hydrogen storage has proven to be very efficient in the advancement and growth of fuel cell and hydrogen technologies in cars, trucks, and other applications.

Nanotechnology towards Solar Energy and Photovoltaics

Photovoltaic energy is produced when light is converted into electrical energy and is attained with the help of semiconductors or photovoltaic solar cells. Various researches are going on where which shows the wide application of Nanotechnology in photovoltaics such as nanoparticle silicon systems; mimicking photosynthesis; nanoparticle encapsulation in polymers; use of non-silicon materials such

as chalcopyrites to develop thin-film technology; molecular organic solar cells; organic polymer photovoltaic systems; development of single-walled nanotubes in conducting polymer cells.
Nanotechnology assists with the formation of second-generation, thin-film PV cells. The emergence of third generation solar cell technologies, where novel technologies like nanowires, quantum dots and radial junctions will begin to hit the upper limits of PV efficiency.
Nanostructures enable in the effective generation of solar cells from economic, more traditional materials, like silicon and titanium dioxide. In 2002, Pacific Solar produced a small Crystalline Silicon Glass module which set the then world record for solar conversion for thin-film crystalline silicon.
Nanotechnology assists in the advancement of photo-electrochemical by the addition of mesoscopic pores in nanocrystalline films, incorporation of nanoparticles to electrodes, strengthening the conductivity of glass substrates, decreasing the electron recombination (Khanna et al., 2008).

According to a report of September 2018, it has been estimated that 11 million American homes have been powered by solar energy, amounting to a total installed solar photovoltaic capacity of 58.3 gigawatts (GW).
According to a recent study in Russia, it was evaluated that a novel technological process for the creation of nano silicon films could be applied to solar cells. This process requires synthesizing solid silicon oxide (SiO) monoxide, following by a disproportionation of solid SiO followed by heat treatment of the material.
Eco Solargy in 2012 introduced a range of solar panels which use self-cleaning glass which keeps the panels free of dirt and debris, to make sure that the PV cells receive as much of the incident solar energy as possible. This approach is very efficient in assisting the conventional cells to perform at peak efficiency.
In May 2012, Northwestern University researchers prepared a new sort of "dye-sensitized" solar cell, which uses an organic dye monolayer to help absorb sunlight, much as plants do for photosynthesis
According to researchers at Michigan Technological University have established a honeycomb-like structure of graphene in which the graphene sheets are held apart by lithium carbonate. They have used this "3D graphene" to replace the platinum in a dye-sensitized solar cell and attained 7.8 percent conversion of sunlight to electricity.
Researchers at Los Alamos National Lab have investigated a solar cell that works on copper indium selenide sulfide quantum dots. Contrary to the quantum dots containing lead or cadmium the copper-based quantum dot is non-toxic as well as low cost.
Researchers are working on a method named Aerotaxy to grow semiconducting nanowires on gold nanoparticles. The aim is to make self-assembly techniques to align the nanowires on a substrate and creating a solar cell or other electrical devices.
Crystalline Silicon on Glass approach incorporates depositing a very thin layer of silicon, directly onto a glass sheet whose surface has been roughened by applying a layer of tiny glass beads. In an oven, the heat treatment is done followed by the transformation of silicon into a crystalline form. The resulting layer is then prepared by using lasers and ink-jet printing techniques to set up the electrical contacts required to get the solar produced electricity out of the thin silicon film.
Companies such as DuPont and General Electricare also involved in R&D relating to photovoltaics and solar technology involving nanotechnology.

Nanotechnology towards Energy Storage
The next generation of batteries or rechargeable batteries, are most suitable for responding to climate change and are used in electric cars and other vehicles. Nanotechnology plays a key role in mainstream R&D with the next generation of rechargeable batteries. The effort on batteries used in hybrid vehicles focused on using nickel-metal-hydride batteries which have wide appliances ion laptops and mobile phones. Companies such as Toyota Prius are already using nickel-metal hydride power cells/batteries. According to a report a Japanese car manufacturer, Nissan has recently developed a new laminated lithium-ion battery for electric vehicles. According to Nissan, it has double the capacity and 1.5 times the power even after 100,000 kilometers usage over five years. It has successfully able to double the driving distance with no increase in battery load.
Stanford researchers have found a way to use silicon nanowires on a stainless steel substrate to rechargeable lithium-ion batteries. Batteries using these anodes produce 10 times the amount of electricity of existing lithium-ion.

Nanotechnology helps in increasing battery power and decreasing the time required to recharge a battery. The benefit can be achieved when nanoparticle forms a coating on the surface of an electrode resulting in the increases in the surface area of the electrode thereby permitting more current to flow between the electrode and the chemicals inside the battery. This technique is efficient in hybrid vehicles by considerably reducing the weight of the batteries required for supplying adequate power.
Nanomaterials assists in increasing the shelf life of a battery by isolating liquids in the battery from the solid electrodes when there is no draw on the battery. This isolation arrest the low-level discharge that happens in traditional batteries, resulting in the increases in the shelf life of the battery.
Various research and practices are being done to develop nano-enhanced batteries for the future and it will mainly focus on reducing the cost of these nanomaterials, making them feasible for large scale commercial applications.
The application of nanotechnology to improve the performance by increasing energy storage density has also permitted much smaller batteries which are less demanding but are beneficial from small, light and flexible rechargeable batteries. Some thin-film batteries are already available, but they are still bounded and are comparatively expensive. The emergences of nano-based research, approach and technology have enhanced the energy and power-density, cyclability and safety of modern batteries.

Potential risk of Nanotechnology to Climate Change

Like any emerging technology, nanotechnology may pose risks to the environment and human health. Several research challenges need to be addressed for the applications of nanotechnology to proceed in a safe and environmentally friendly manner.
Nanotechnology will be influential and engulfed in all aspects of daily life. So, knowledge regarding the exposure to nanomaterials resulting from the medical, occupational, environmental, and accidental release is critically required for nanotechnology risk assessment. Details about the concentration of nanomaterials as well as what form(s) they may assume upon release into the environment are essential. Due to the size and physicochemical characteristics of nanomaterials, innovative monitoring methods will be required to execute nanomaterial exposure assessments.
The emergence of Nanotechnology has raised concerns over nanotechnology risk and safety aspects concerning respect to environment and health safety (EHS) as well as its ethical, legal and social implications (ELSI). The World over, countries are vying to establish a regulatory framework to address these concerns. The initiatives in this regard comprise enacting new regulations or amending existing regulations/laws for nanotechnology; enforcing safety guidelines for researchers/workers in the laboratories in universities/research centers or companies and establishing a global standard.

Future of Nanotechnology towards Climate Change

Nanotechnology will make vital contributions to science and engineering for the future generation and inherently will restructure many present technologies.
A detailed research needs to be carried out for future generations so that nanotechnology can contribute to addressing climate change. Further, it is needed to consider ways to overcome obstructions such as inefficient infrastructure (as in the case of the hydrogen economy), limitedsupply of raw materials (such as silicon utilized in photovoltaics) as well as other barriers such as lack of government policies and incentives that inhibit the adoption of these technologies.
The current energy sources are highly dependent on fossil-based crude oil. So to avoid future energy problems due to the limited availability of crude oil, the possibility to use alternative energy sources should be assessed. An alternative source can be ethanol, presently made from plants such as corn and sugar cane. Researchers are working to evolve procedures for producing ethanol from different other types of plant material; which may considerably increase the amount of ethanol available as fuel. Nanotechnology may assist in this endeavor.
Paris COP21 climate talks, Russia proposed to minimize its greenhouse gas emissions by 70% by the year 2030. This attempt will involve five materials: steel, cement, aluminum, plastic and paper. The procedure to attain this will be by implementing nanotechnologies such as carbon nanomaterials to make these materials lighter, stronger, stiffer and more efficient (Kristen Kulinowski, 2006).

CONCLUSION

The evolution of nanotechnology can be a solution to future energy problems. Nanotechnological products, procedures, approach and applications are expected to contribute significantly to environmental and climate protection by saving raw materials, energy and water, reducing

greenhouse gases and hazardous wastes, sustainable development, preservation of nature, conservation of human population and other living beings, elimination of wastage and reusability, enhancing the efficiency of existing power generation methods. Nanotechnology can separate the finest contaminants from water supplies and air as well as continuously measure and mitigate pollutants in the environment, therefore, it promises certain environmental benefits and sustainability effects. Nanotechnology has great and constantly growing implications for renewable energy, a matter that can lead to a higher potential of energy generation and storage. In this situation, the development of nano-based technology could contribute to the better improvement and result in a more effective and efficient process to produce and utilize the energy as well as an application for environmental purposes. No proper 'Regulatory Framework' has been made in this very new field and if this continues for long then nations may come to dominate this field. India must, therefore have systematic schemes, coordinated policies and include institutions and industry for the evolution of Nano Technology in all spheres of life primarily to address environmental and climate change issues.

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REFERENCES

Ahmed, T., Hyder, M.Z., Liaqat, I. and Scholz, M. (2019). *International Journal of Environmental Research and Public Health*, 16, 3165.

Gasper, R., Bolhm, A. and Ruth, M. (2011). Current opinion on environmental stability.

Ghosal, M. and Thomas, S. (2018). Nanotechnology to Mitigate Environment and Climate Change Issues. Consulting Engineers Association of India.

Khan, W.S., Ceylan, M., Asmatulu, E. and Asmatul, R. (2012). Effects of nanotechnology on global warming, midwest section, Conference of the American Society for Engineering Education.

Khanna, V., Bakshi, B.R. and Lee, L.J. (2008). "Carbon Nanofiber Production: Life Cycle Energy Consumption and Environmental Impact," *J. Industrial Ecology*, vol. 12, no. 3, pp. 394-410.

Kristen Kulinowski, (2006). ÔNanotechnology: From ÔWowÕ to ÔYuckÕ? Õ in G. Hunt and M. Mehta (eds), Nanotechnology. Risk, Ethics and Law.

K.R.V.S. (2017). An Overview on Role of Nanotechnology in Green and Clean Technology. Austin Environmental Sciences.

Rajput, N. (2017). Development of Nanotechnology in India: A Review. IOSR Journal of Applied Physics, e-ISSN: 2278-4861.Volume 9.

Webersik, M., C. Leary, D. and Thompson-Pomeroy, D. (2008). Innovation in Responding to Climate Change: Nanotechnology, Ocean Energy and Forestry. United Nations University Institute of Advanced Studies.

Report on national nanotechnology initiative workshop, 2010.

Australian Bureau of Agricultural and Resource Economics, Energy security, clean technology development and climate change. Addressing the future challenges in APEC, ABARE Research Report 07.14 (2007).

www.azonano.com

www.nanowerk.com

https://www.understandingnano.com/

< https:// www.abareconomics.com/publications_html/climate/ climate_07/apec_security.pdf> at 27 September 2007

Nissan Corporate web site http://www.nissan-global. Com /EN/TECHNOLOGY/INTRODUCTION/DETAILS/EVLB/

Corresponding author: Dr. T.S. Naqvi, Department of Zoology, Shia P.G., College, Lucknow, U.P., India
Email: tsnaqvi8@gmail.com