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Nano Technology Applications, veritable Tools to the Mitigation of Global Climate Change

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ABSTRACT

In the Recent times, global climate change has posed a great danger to humanity. It is any identifiable change in the worldwide climate that has occurred over decades or more. In this modern time, researchers have identified Green House Gases as the cause of global climate change. Green House Gases are from natural and anthropogenic sources. The industrial revolution of 20th century to a very large extent has contributed to the warming trend. Climate model projections indicated that during the 21st century the global surface temperature is likely to rise a further 0.3 to 1.7 °C for their lowest emissions scenario using stringent mitigation and 2.6 to 4.8 °C for their highest. Reducing Green House Gas emission requires us to change the way we generate electricity, heat our homes and our means of transportation. These changes include generation of green energy through renewable energy sources, using green nano technologies, less carbon intensive fuels/more energy efficiency and carbon capture/ sequestration.

Key words: Global Climate Change, Green House Gases, Green Nano Technology and Carbon Sequestration.

INTRODUCTION

1.1 CLIMATE CHANGE

Climate involves the average weather condition over a long period of time [1]. The main components of weather are amount of incoming solar radiation, the amount of out-going radiation from terrestrial surfaces (albedo), atmospheric temperature, humidity and rainfall. Global climate change occurs when there is persistent deviation over a long period of time from the average values of the aforementioned parameters of the climate of the Earth and the climate becomes unstable and unpredictable.

In recent times, scientific understanding of global warming has increased. In 2014, Intergovernmental Panel on Climate Change (IPCC) reported that scientists were more than 95% certain that global warming is mostly being caused by increasing concentrations of greenhouse gases (GHG) and other human (anthropogenic) activities, [2,3,4]. Furthermore, climate model projections summarized in the report indicated that during the 21st century the global surface temperature is likely to rise a further 0.3 to 1.7 °C (0.5 to 3.1 °F) for their lowest emissions scenario using stringent mitigation and 2.6 to 4.8 °C (4.7 to 8.6 °F) for their highest, [5]. These findings have been recognized by the national science academies of the major industrialized nations, [6] and are not disputed by any scientific body of national or international standing, [7].

Generally, it is caused by changes in the atmosphere resulting from either natural (volcanoes, plate tectonics, solar changes etc) or anthropogenic sources such as fossil fuel burning, urbanization and industrial activities etc. The main force driving climate change today is global warming, [8]. In more than 4,000 academic papers published over 20 years, 97% agreed that climate change is anthropogenic, [9]. This is the persistent significant increase in atmospheric temperature due to accumulation of greenhouse gases in the lower atmosphere. These gases include carbon dioxide, methane, nitrous oxide, tropospheric ozone and chlorofluorocarbons. Methane is produced mainly from rice paddles, ruminants, marshes and natural gas exploitation. Its concentration in the atmosphere is increasing at a rate of 1.1% per annum and its injection into the atmosphere is about 400 million tonnes per year. Nitrous oxide is produced from hydro carbon. Chlorofluorocarbons widely used in refrigerators cause progressive depletion of the ozone layer which shuts out dangerous ultraviolet rays from penetrating the atmosphere and reaching the earth surface. Ozone layer depletion has created a hole in the ozone layer over the Arctic region, allowing massive increase in solar radiation reaching the atmosphere and warming it, [14].

CO_2 is produced from increased industrial activity (fossil fuel burning) and other activities such as cement production and tropical deforestation. Unless the amount of CO_2 and other greenhouse gases entering the atmosphere is reduced dramatically, scientists predicted that the temperature of the earth will continue to rise. This rise in temperature will cause the climate to change and the impact felt on the environment.

1.2 IMPACT OF CLIMATE CHANGE

Climate change is a monster that threatens human existence in this present time. Global sea level has rose to about 17 centimeters (6.7 inches) in the last century. The rate of rise in the last decade is nearly double that of the last century [11] The three major global surface temperature reconstructions show that the Earth has warmed since 1880 [12]. Most of this warming is since 1970s, with the 20 warmest years having occurred since 1981. 10 of the 20 warmest years occurred in the past 12 years [13]. The 2000s witnessed a solar output decline resulting in an unusually deep solar minimum in 2007-2009 and still surface temperature continues to increase [14]. This increased heat is much absorbed by ocean with the top 700 meters of ocean showing warming of 0.302 degree Fahrenheit since 1969 [15]. The Greenland and Antarctic ice have decreased in mass. Data from NASA’s Gravity Recovery and Climate Experiment show Greenland lost to be 150 to 250 cubic kilometers (36 to 60 cubic miles) of ice per year between 2002 and 2006 while Antarctica lost about 152 cubic kilometers (36 cubic miles) of ice between 2002 and 2005. The extent and thickness of Arctic sea ice has declined rapidly over the last several decades [16]. Glaciers are retreating almost everywhere around the world including in the Alps, Himalayas, Andes, Rockies, Alaska and Africa [17]. The number of record high temperature events in the United State has been increasing while the numbers of record low temperature events has been decreasing since 1950. The U.S. has also witnessed increasing numbers of intense rainfall events [18]. Since the beginning of the industrial revolution, the acidity of surface ocean waters has increased by about 30 percent [19,20]. This increase is the result of anthropogenic activities that emits more carbon dioxide into the atmosphere and hence more being absorbed into the oceans. The amount of carbon dioxide absorbed by the upper layer of the oceans is increasing by about 2 billion tons per year [21, 22].

These changes in climate system lead to the increase in the frequency and intensity of the worldwide tornado, hurricanes, sand storms, dust storms and ocean surges. Changing temperature and rainfall patterns have brought about intensification of desertification and drought with adverse consequences on health, water quality and quantity, agriculture/food security and famine, air pollution, social dislocation and infectious diseases. In Nigeria climate change induced submergence is already taking place in many parts of the country.

1.3 Mitigation and adaptation.

Various methods could be used to mitigate the effect of climate but here we are interested in the application of nano technology and this is achieved through the following methods.

a. Reducing energy consumption by employing more efficient technologies that minimize use of fossil fuels
b. Adopting technologies that utilize renewable energy and energy storage technologies
c. Addressing carbon management issues through that capture, sequestration and conversion to useful products

1.3a. Reducing Energy Consumption by Employing more Efficient Technologies that Minimize the use of Fossil Fuels.

The major impact of nanotechnology on the energy sector is to improve the efficiency of present day technologies in minimizing the usage of fossil fuels. This is achieved through the following methods; (i) Reduction in the sizes and weights of engine and vehicle parts. This contributes to the decrease in fuel consumption which can have significant global impact because reduction in fuel consumption leads to reduced emissions. It is estimated that a 10% reduction in weight of the engine and vehicle parts corresponds to a 10% reduction in fuel consumption, leading to a proportionate fall in emissions, [23]. Going by this development, there is worldwide growing interest in exploring means of achieving weight reduction in automobiles and stationary sources through the use of nano materials. Polymers like thermosets, thermoplastics, elastometer reinforced with colloidal silica, nanoclay and nanotubes are promising materials. Nanocatatalysts are used to improve the efficiency of fuel products used in combustion engines. Enercat, a third generation nanocatalist developed by Energenics, uses oxygen storing cerium oxide nanoparticles to promote complete fuel combustion, which helps in reducing fuel consumption, [23]. (ii) Reducing friction can lower the fuel consumption by about 2% and result in cutting down carbon dioxide emissions by 500 million tons per year from trucks and other heavy vehicles. An estimate made by a Swedish company shows that nano based lubricants and nanocoatings can significantly reduce coefficient of friction and this is being introduced in the market [23].

1.3b Adopting technologies that utilize renewable energy and energy storage technologies

The task of **s**aving the environment from the disaster of climate change is a collective responsibility and calls for adopting technologies that utilize renewable energy and energy storage technologies like biomass, biofuels, hydrogen fuel, fuel cells, solar panels and collectors. Current solar cell technologies are mainly based on silicon (single or polycrystalline silicon) which is very expensive to manufacture and have limited efficiency. The use of organic or plastic thin film solar cells is a cheap alternative; mainly based on nanoparticles and polymers and are now being used to manufacture flexible solar panels. The material requirement is much less than that of silicon wafers and hence, costs effective. Flexible substrate technology also enables use of continuous roll processing technique, rather than the step processing technique being used in a semiconductor plant, thereby resulting in dramatic cost reductions, [23]. The cheap alternative is found in amorphous silicon or nanoscaled CdS, CIS, CdTe, TiO2, ZnO, Cu_2O, Quantum Dots, organic materials etc., [24].

1.3c. Addressing carbon management issues through that capture, sequestration and conversion to useful products.

Carbon sequestration is the process involved in carbon capture and long term storage of atmospheric carbon dioxide (CO_2), [25]. This carbon is always captured from CO_2 produced from stationary and non-stationary sources. Carbon sequestration describes long-term storage of CO_2 or other forms of carbon to either mitigate global warming or avoid dangerous climate change. It has been proposed as a way to slow the atmospheric and marine accumulation of greenhouse gases which are released by burning fossil fuels, [26]. When captured and buried under ground we have geosequestration. The concept of geosequestration involves liquifying carbon dioxide and depositing it into mineral zones below the earth's surface where chemical reactions of the liquid CO_2 with minerals stabilize it in solid form.

In olivine-rich rock dunite, or its hydrated equivalent, serpentinite with carbon dioxide form carbonate mineral magnesite, plus silica and iron oxide (magnetite). The olivine is a mineral of magnesium iron silicate with formula $(Mg^{+2}, Fe^{+2})_2SiO_4$. It is a type of nesosilicate or orthosilicate and a common mineral in the Earth's surface. It is in nano scale and is used to sequester CO_2 through serpentinite reaction. When olivine is crushed, it weathers completely within a few years, depending on the grain size. All the CO_2 that is produced by burning 1 litre of oil can be less than 1 litre of olivine. The heat produced can be used to generate electricity, [27 and 28]. Serpentinite sequestration is favored because of the non-toxic and stable nature of magnesium carbonate.

CONCLUSION

Climate change is real. It is a monster that haunts both scientist and non-scientist. The advent of industrialization has aggravated the quantity of greenhouse gases in the atmosphere, with attendant consequences on temperature variations. Many scientific and technological research groups study the causes, consequences and mitigation of climate change; but as a multidisciplinary subject, each group can only study an aspect of climate change. This paper has reviewed the role of carbon dioxide as a main agent of climate change. Carbon dioxide present in the atmosphere can be controlled both by enhance natural mechanisms and artificial methods like, sequestration and the use of nano technology. Funding is thus advocated from governments and policy makers.

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