Nano Technology Applications, Veritable Tool to Mitigating the Effect of Global Warming on Climate Change.

Don Okpala Uche, Ph.D.

DEPARTMENT OF PHYSICS, ANAMBRA STATE UNIVERSITY, ULI, ANAMBRA STATE, NIGERIA.

Abstract: In this work, the application of nano technology to the mitigation of the effects of global warming is studied. Global warming is a function of increase in green house layer as a result of the buildup of greenhouse gases. Researchers have identified greenhouses gases as the cause of global warming which in turn leads to climate change. Greenhouse gases are from natural and anthropogenic sources. Records show that since 1851, we have been in the warming trend; the average temperature has increased by $1^{o}C$. The rate and duration of the warming in 20^{th} century is larger than any other time in the last 1000 years. Reducing greenhouse gas emission requires us to change the way we generate electricity, heat our homes and our means of transportation. These changes include generation of renewable energy sources, using less carbon intensive fuels/more energy efficiency, green nano technologies and carbon capture/ sequestration. Man has the choice of researching into alternatives to emission reductions or allows emissions to continue and then prepare for global climate change disaster.

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

1.1 INTRODUCTION

Man in his attempt to dominate the earth is depleting natural resources and degrading his local environments. Populations have also modified their local climates through cutting of trees (deforestation in the tropics) for the purpose of development. There has been a dramatic increase in greenhouse gases, particularly carbon dioxide (CO_2). The use of fossil fuel (coal, oil, and gas) in power plants, automobiles, industrial facilities and other sources contributes to the large source of CO_2. The US National Oceanic and Atmospheric Administration (NOAA) said that the CO_2 level in the atmosphere now stand at 387 parts per million (ppm) about 40% since the industrial revolution, [1]. Global warming is the observed century-scale rise in the average temperature of the Earth's climate system, [2]. Scientific research has made it evident that the climate system is warming, [3, 4 and 14]. The increase of near-surface atmospheric temperature is the measure of global warming often reported in the popular press, most of the additional energy stored in the climate system since 1970 has gone into ocean warming. The remainder has

melted ice, and warmed the continents and atmosphere, [5]. Many of the observed changes since the 1950s are unprecedented over decades to millennia, [6]. In 2014, the Intergovernmental Panel on Climate Change (IPCC) reported that scientists were more than 95% certain that global warming is being caused mostly by increasing concentrations of greenhouse gases and other anthropogenic activities, [7]. 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 emission scenario using stringent mitigation and 2.6 to 4.8 °C (4.7 to 8.6 °F) for their highest, [8]. These findings have been recognized by the national science academies of the major industrialized nations, [9] and are not disputed by any scientific body of national or international standing, [10].

In the future climate change and associated impacts will differ from region to region around the globe, [11]. The effects include warming global temperature, rising sea levels, changing precipitation and expansion of desert in the subtropics, [12]. Warming is expected to be greater over land than over the oceans and greatest in the Arctic with the continuing retreat of glaciers, permafrost, sea ice, extreme weather events including heat waves, draught, heavy rainfall with floods and heavy snowfall, [13]. Its effect on human includes food security from decreasing crop yields, internal displacement for those living on low land and water ways due to rising sea levels, [14]. Climate change is a function of global warming. Climate change is a variation in the average weather condition. Global warming is increasing the frequency and intensity of the worldwide tornado, hurricanes, sand storms, dust storms and ocean surges [15]. 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. Evidence of man's contributions to global warming is shown on figure 1: US greenhouse gas emissions from 1990-2007.

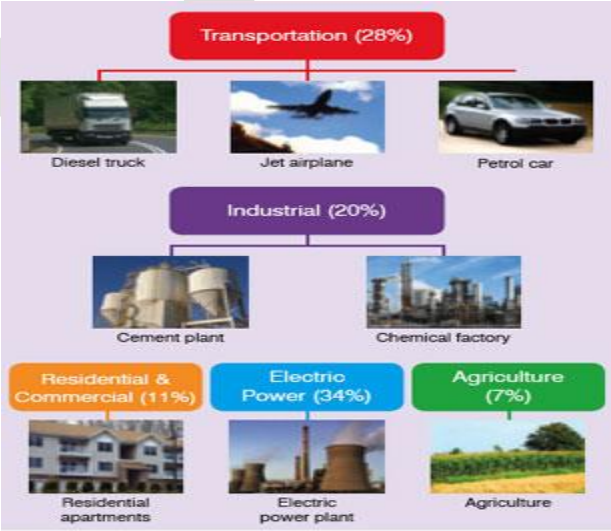

Fig. 1: U.S. Greenhouse Gas Emissions, [16]

1.2 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 that involve separation, capture, sequestration and conversion to useful products

1.2a. 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 contribute 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, [17]. 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, [17]. (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, [17].

1.2b Adopting technologies that utilize renewable energy and energy storage technologies

The need to save the environment from the disaster of climate change 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). However, they are expensive to manufacture and have limited efficiency. The high cost of silicon-based solar cells has been the

greatest barrier to their widespread adoption. Organic or plastic thin film solar cells are a low cost alternative, mainly based on nanoparticles and polymers, and are now being used to manufacture flexible solar panels. The thin film technology is also cost effective, and uses a cheap polymer substrate coated by a thin film of an active component. The material requirement is much less than that in case of silicon wafers and, hence, the costs are further reduced. 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, [17].

1.2c Addressing Carbon Management Issues that Involve Separation, 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), [18]. 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, [19].

It has been proposed as a way to slow the atmospheric and marine accumulation of greenhouse gases which are released by burning fossil fuels, [19]. 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.

One proposed reaction is that of the olivine-rich rock dunite, or its hydrated equivalent, serpentinite with carbon dioxide to form the 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, [20 and 21]. Serpentinite sequestration is favored because of the non-toxic and stable nature of magnesium carbonate.

1.3 Conclusion

The globe is really warming and this lead to climate change. It is a monster that haunts both scientist and non-scientist. The advent of industrialization has aggravated the mount of greenhouse gases in the atmosphere, with attendant consequences on temperature variations.

Many scientific and technological research groups23ws 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 global warming. Carbon dioxide present in the atmosphere can be controlled both by enhanced natural mechanisms and artificial methods like sequestration and the use of nano technology. Governments should make policies that would dissuade people from irregular use of fossil energy like setting an emission ceiling that countries cannot go and make funds available for research into alternative energy sources that are environmentally friendly.

REFERENCES

[1] NOA USA

[2] IAP (June 2009), Interacademy Panel (IAP) Member Academies Statement on Ocean Acidification, Secretariat: TWAS (the Academy of Sciences for the Developing World), Trieste, Italy.

[3] IEA (2009). World Energy Outlook 2009 (PDF). Paris, France: International Energy Agency (IEA).

[4] IPCC AR4 SYR (2007). Core Writing Team; Pachauri, R.K; and Reisinger, A., eds. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC.

[5] IPCC AR4 WG2 (2007). Parry, M.L.; Canziani, O.F.; Palutikof, J.P.; van der Linden, P.J.; and Hanson, C.E., ed. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

[6] IPCC AR4 WG3 (2007). Metz, B.; Davidson, O.R.; Bosch, P.R.; Dave, R.; and Meyer, L.A., ed. Climate Change 2007: Mitigation of Climate Change. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

[7] IPCC AR5 WG1 (2013), Stocker, T.F.; et al., eds., Climate Change 2013: The Physical Science Basis. Working Group 1 (WG1) Contribution to the Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report (AR5), Cambridge University Press.

[8] IPCC SAR SYR (1996). "Climate Change 1995: A report of the Intergovernmental Panel on Climate Change". Second Assessment Report of the Intergovernmental Panel on Climate Change. IPCC. pdf. The "Full Report", consisting of "The IPCC Second Assessment Synthesis of Scientific-Technical Information Relevant to Interpreting Article 2 of the UN Framework

Convention on Climate Change" and the Summaries for Policymakers of the three Working Groups.

[9] IPCC SAR WG3 (1996). Bruce, J.P.; Lee, H.; and Haites, E.F., ed. Climate Change 1995: Economic and Social Dimensions of Climate Change. Contribution of Working Group III to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

[10] IPCC TAR WG1 (2001). Houghton, J.T.; Ding, Y.; Griggs, D.J.; Noguer, M.; van der Linden, P.J.; Dai, X.; Maskell, K.; and Johnson, C.A., ed. Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

[11] IPCC TAR WG2 (2001). McCarthy, J. J.; Canziani, O. F.; Leary, N. A.; Dokken, D. J.; and White, K. S., ed. Climate Change 2001: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

[12] US Global Change Research Program (USGCRP) document: NCADAC (2013), Federal Advisory Committee Draft Climate Assessment. A report by the National Climate Assessment Development Advisory Committee (NCADAC), Washington, D.C., USA.

[13] USGCRP (2015), Glossary, Washington, DC, USA: U.S. Global Change Research Program (USGCRP), retrieved 20 January 2014.

[14] National Research Council (2011), Climate Stabilization Targets: Emissions, Concentrations, and Impacts over Decades to Millennia, Washington, D.C., USA: National Academies Press.

[15] IPCC AR4 WG1 (2007). Solomon, S.; Qin, D.; Manning, M.; Chen, Z.; Marquis, M.; Averyt, K.B.; Tignor, M.; and Miller, H.L., ed. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

[16] U.S. Greenhouse Gas Emissions by Economic Sector (2007) (Source: Environmental Protection Agency (EPA), Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007, Table ES-7, 2009).

[17] Cientifica (2007), Quantifying the Effect of Nanotechnologies on CO2 Emissions, Nanowek.

[18] Sedjo, Roger; Sohngen, Brent (2012). "Carbon Sequestration in Forests and Soils". Annual Review of Resource Economics (Annual Reviews) **4**: 127–144.

[19] Hodrien, Chris (October 24, 2008). Squaring the Circle on Coal - Carbon Capture and Storage (PDF). Claverton Energy Group Conference, Bath. Retrieved May 9, 2010.

[20] Goldberg, P.; Chen, Z.-Y.; O'Connor, W.; Walters, R.; Ziock, H. (2000). "CO_2 Mineral Sequestration Studies in US". *Technology* **1** (1): 1–10.

[21] Schuiling, R. D.; Krijgsman, P. (2006). "Enhanced Weathering: An Effective and Cheap Tool to Sequester CO_2". Climatic Change **74** (1–3): 349–354.

[22] Batjes, Niels H. (1996). "Total carbon and nitrogen in the soils of the world". *European Journal of Soil Science* **47** (2): 151–63.

[23] Chester, Bronwyn (20 April 2000). "The case of the missing sink". McGill Reporter. Retrieved 8 July 2008.

[24] IPCC AR5 WG2 A (2014), Field, C.B.; et al., eds., Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects (GSA). Contribution of Working Group II (WG2) to the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press.

[25] IPCC AR5 WG3 (2014), Edenhofer, O.; et al., eds., Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III (WG3) to the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press.

[26] IPCC SREX (2012). Field, C.B. et al., eds. "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX)". Cambridge University Press.. Summary for Policymakers Summary for Policymakers.

[27] IPCC TAR WG3 (2001). Metz, B.; Davidson, O.; Swart, R.; and Pan, J., ed. Climate Change 2001: Mitigation. Contribution of Working Group III to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

[28] National Research Council (2010). America's Climate Choices: Panel on Advancing the Science of Climate Change; Washington, D.C.: The National Academies Press.