Investigations of Catalytic and Optical Behaviour of Nanodiamond Aerosols and Thin Aerosol Films

Solar geoengineering or solar management potentially allows us to deliberately introduce changes to the Earth’s radiative balance to partially offset the radiative forcing to lessen the risks of climate change. Although this proposed approach has triggered a lot of political debate worldwide this may become soon the only option to us to sustain on our Planet Earth.

Recently the large increase in amounts of methane plumes is detected reaching the Earth’s surface from depths of 500 m below sea level where it is known that there are large quantities of frozen methane hydrate stored [1]. However, if this release of methane continues to increase further (due to the warming of seawater at intermediate depths [1]) this will cause an uncontrollable rise in the Earth’s temperature. The process is self-perpetuating and there is no control over how much methane is released. Therefore only partially offsetting of the radiative forcing of accumulating greenhouse gases will be the option.

In solar geoengineering solid aerosols have been proposed as an alternative to sulfate aerosols for solar geoengineering due to increased Mie and Rayleigh scattering [2]. Recently it has been theoretically predicted that appropriately sized alumina, diamond or similar high-indexed particles have less severe technology specific-risks than sulfate aerosols [2]. For the same irradiative forcing the solid aerosols can produce less ozone loss, less stratospheric heating and less forward scattering than sulfate aerosols do. It has been predicted that nanodiamond aerosols made of nanodiamonds monomers below in diameter range between 50 nm and 600 nm are the most effective radiative upscatterers [2]. In order for this proposed technology become available the evaluation of predicted nanodiamond aerosols in the laboratory have to be experimentally confirmed. Furthermore, the catalytic activities of dry surfaces of the solid nano-diamond aerosols needs to be examined because for example they may catalyse reactions that will cause ozone loss [3]. There is also some evidence that diamond nanoparticles are nontoxic to biological systems [4] although further research is needed in this area.

So the main purpose of the PhD project is to experimentally evaluate the potential of diamond nanoparticles as aerosols. This proposed research is possible to carry out at Newcastle University because a first method of de-agglomeration of nanodiamonds and micronsized diamonds in powder form have been developed at Newcastle University [4]. So the right de-agglomerated particle size range can be selected (larger particles will can stay for shorter period in atmosphere and re-injections would be much more frequently needed). Technology has been patented worldwide by Dr Siller and Dr Butenko, Newcastle University [5] and licenced with the recent technology transfer to Element 6 Ltd (part of De Beers) in October 2015.
The main objective of the PhD is to de-agglomerate and size select 0-2 micron sized industrial powder in gram quantities supplied by Element 6 (by our patented method) and build aerosol generator based on design of J. Akedo [5] for the preparation of nanodiamond aerosols and aerosol dry films to investigate the theoretical predictions. The diamond aerosols and dry aerosol films will be exposed to sulfates and/or ozone. At Newcastle an ozone generator and solar simulator are available to investigate the catalysis of dry nanodimond powders.

The PhD student will be trained with expertise across disciplines covering synthesis, material science, characterization, engineering, and material processing, in addition to transferable skills.

References:

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