Materials from geochemically inspired studies : from Titan's tholins to extremophile bacteria

PAUL F MCMILLAN[1]

[1]Dept. of Chemistry, University College London, 20 Gordon St., London WC1H 0AJ, UK

Geochemistry and experimental geology studies have long been linked to the identification and processing of new materials with great technological importance and high societal impact. Examples range from hydrothermal and sol-gel synthesis of ceramics to development of techniques for *in situ* studies of functional materials under extreme conditions. New research extending from planetary sciences to deep life geochemistry are leading to new developments in nanomaterials technology and biochemical processing with medical and forensic applications. Here we describe and discuss recent results that extend from fundamental studies and interplanetary based observations of Titan's atmosheric aerosols to new materials being developed for efficient charge storage and energy use applications on Earth, to the involvement of new studies of extremophile bacteria in the deep Earth enviroment to development of nanotechnology and biomedical applications. These examples will illustrate the continued and emerging links between geochemistry, advanced materials science and biology, with enormous benefits to society.

Secondary organic aerosol formation in aerosol water: Impact on aerosol physical properties

V. FAYE MCNEILL[1]

[1]Department of Chemical Engineering, Columbia University, New York, NY, USA 10027 vfm2103@columbia.edu

The chemistry of atmospheric aerosols influences their direct and indirect effects on climate. Inorganic aerosols may acquire an organic component via *in situ* interactions with volatile organic compounds (VOCs), a family of processes known as secondary organic aerosol (SOA) formation. SOA formation is one of the greatest sources of uncertainty in estimations of aerosol climate forcing. Pathways for aqueous-phase SOA formation have been identified in which water-soluble VOCs dissolve into cloud droplets or wet aerosols, followed by aqueous-phase reactions which lead to the formation of SOA material. Our recent laboratory studies show that particle-phase chemical reactions between organics and inorganic salts can lead to secondary organic products which absorb light in the UV and visible, thus changing the optical properties of the particle. We have also shown that aqueous-aerosol SOA products may be surface-active, therefore potentially enhancing the ability of small particles to nucleate cloud droplets (CCN activity). In addition to these bulk surfactant effects, our work demonstrates that the surface adsorption of methylglyoxal and acetaldehyde from the gas phase can depress aerosol surface tension and increase CCN activity. Finally, I will introduce a photochemical model of coupled gas and detailed aqueous aerosol chemistry that we have developed in order to study the formation of secondary organic aerosol material in aerosol water and the associated changes in aerosol physical properties. I will present results for atmospheric scenarios and highlight needs for additional experimental work.

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