Greigite: synthetic routes and catalytic testing for CO_2 reduction

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Despite the high thermodynamic stability of CO_2, biological systems are capable of both activating and converting CO_2 into a range of organic molecules, under moderate conditions. It is clear that if we were able to emulate nature and successfully convert CO_2 into useful chemical intermediates without the need for extreme reaction conditions, the benefits would be enormous: one of the major gases responsible for climate change would become an important feedstock for the chemical industries.

Iron sulfide membranes formed in the warm, alkaline springs on the Archaean ocean floor are increasingly considered to be the early catalysts for a series of chemical reactions leading to the emergence of life. The anaerobic production of acetate, formaldehyde, amino acids and the nucleic acid bases – the organic precursor molecules of life – are thought to have been catalysed by small cubane clusters, which are structurally similar to the surfaces of present day sulfide minerals such as greigite (Fe_3S_4).[1]

Here we report routes to synthesise phase pure nanoparticulate mineral greigite and present the results of electro-catalytic testing at atmospheric pressure (AP) and room temperature. We show, through quantitative ^{1}H-NMR analysis, the formation of small organic products at low over potentials (0→ -1V). pH studies are presented to determine the reactivity of CO_2 *vs* HCO_3^- *vs* CO_3^{2-} at AP and the stability of the catalyst during the reduction process is discussed. The results of which provide support for alkaline hydrothermal vents and possible loactions for the origin of life.

[1] M.J. Russell, *Science* (2003) **302**, 580.