

PRODUCTION OF ORGANIC GRAIN COATINGS BY SURFACE-MEDIATED REACTIONS AND THE CONSEQUENCES OF THIS PROCESS FOR METEORITIC CONSTITUENTS Joseph A. Nuth III AND Natasha M. Johnson, Astrochemistry Laboratory Code 691, NASA's Goddard Space Flight Center, Greenbelt MD 20771 (Joseph.A.nuth@NASA.gov).

Introduction: When hydrogen, nitrogen and CO are exposed to amorphous iron silicate surfaces at temperatures between 500 - 900K, a carbonaceous coating forms via Fischer-Tropsch type reactions¹. Under normal circumstances such a catalytic coating would impede or stop further reaction. However, we find that this coating is a better catalyst than the amorphous iron silicates that initiate these reactions^{2,3}. The formation of a self-perpetuating catalytic coating on grain surfaces could explain the rich deposits of macromolecular carbon found in primitive meteorites and would imply that protostellar nebulae should be rich in organic material. Many more experiments are needed to understand this chemical system and its application to protostellar nebulae.

Planetary Noble Gases: If FTT reactions form macromolecular carbonaceous coatings on grain surfaces in the primitive solar nebula, then such reactions could be responsible for trapping ambient nebular gas, including the Planetary Noble Gas component found in many primitive meteorites^{4,6}. As a corollary, if we can show that the planetary noble gases are trapped in such coatings, and measure the trapping efficiency for this process, then we might be able to use measurements of the noble gas content of meteorites and of samples returned from comets and asteroids to estimate the fraction of solar system organics that were produced via such reactions. We have begun to carry out such experiments in our laboratory.

Experiment: The experiments reported here are very simple and were designed to test the relative efficiency of various catalysts as a function of temperature. We have slightly modified our procedure to simultaneously study the trapping efficiency of noble gases as the coatings are produced. A schematic diagram of the closed-cycle apparatus is shown in Figure 1.

Other Consequences: The efficient operation of surface mediated conversion of CO into organic materials, especially into coatings in intimate contact with silicate grains, could act to reverse the effects of CO self shielding on the oxygen isotopic composition of dust in the solar nebula. In the simplest case, the ¹⁶O-depleted water vapor and the ¹⁶O enriched CO should remain closely coupled barring significant separation of gas and dust. Conversion of CO into dust coatings, followed by grain destruction via lightning would simply lead to remixing of the oxygen in the CO and water to reform CO and water with the original solar composition.

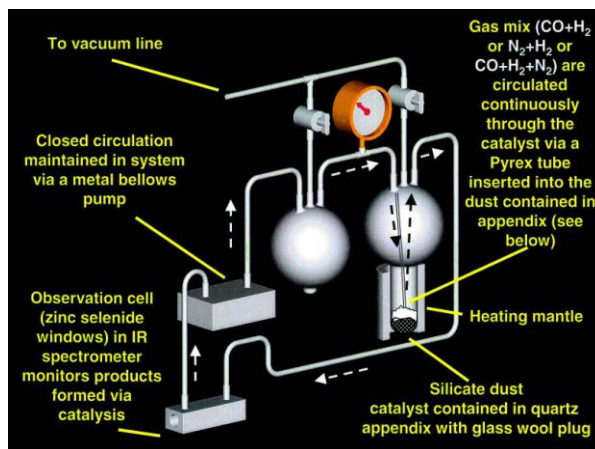


Figure 1. Schematic drawing of the system. The (smoke) catalyst is contained in the bottom finger of a 2-liter Pyrex bulb that can be heated to controlled temperatures. A Pyrex tube brings reactive gas to the bottom of the finger. The gas then passes through the catalyst into the upper reservoir of the bulb, flows through a copper tube at room temperature to a glass-walled observation cell (ZnSe windows) in an FTIR spectrometer and a closed-cycle metal bellows pump returns the sample via a second 2-liter bulb and the Pyrex tube to the bottom of the catalyst finger to start the cycle over again. The gas mixture initially consists of 75 torr N₂, 75 torr CO & 550 torr of H₂. Total pressure is reduced as the reaction proceeds, is monitored via a diaphragm gauge placed in-line between the two bulbs and has been observed to vary from highs near 750 torr to low pressures near 600 torr. To this gas mixture we now add 25 torr of a rare gas mixture consisting of 49% Ne, 49% Ar, 1% Kr and 1% Xe.

References: [1] Hill, H. G. M. and Nuth, J. A. (2003) *Astrobiology* **3**, 291 - 304. [2] Nuth J.A., Johnson, N.M. and Manning, S., 2008a *Ap. J. (Lett.)* **673** L225 - L228. [3] Nuth J.A., Johnson, N.M. and Manning, S., 2008b in *Organic Matter in Space*, Proceedings IAU Symposium No. 251, 2008 (S. Kwok & S. Sandford, eds.) pp. 403 - 408. [4] Huss G. R., Lewis R. S., and Hemkin S. (1996) *Geochim. Cosmochim. Acta* **60**, 3311-3340. [5] Wieler R., Anders E., Baur H., Lewis R.S., & Signer P. (1991) *Geochim. Cosmochim. Acta* **55**, 1709-1722. [6] Wieler R., Anders E., Baur H., Lewis R.S., & Signer P. (1992) *Geochim. Cosmochim. Acta* **56**, 2907-2921..