Synthesis of refractory organic matter in the ionized gas phase of the Solar Nebula

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In the nascent solar system, primitive organic matter was a major contributor of volatile elements to planetary bodies. Most organic matter found in primitive chondrites occurs as insoluble organic matter (IOM). Despite many characterization efforts, the origin, nature of precursors and synthesis of this IOM is poorly understood [1]. Most scenarios advocate cold synthesis in the interstellar medium or in the outer solar system [2-3].

Here, we report the synthesis of solid organics under ionizing conditions in a plasma setup [4] from gas mixtures (H_2(O)-CO-N_2-Noble gases) reminiscent of the protosolar nebula composition. Ionization of the gas phase was achieved at temperature up to 1000 K. Synthesized solid compounds share chemical and structural features with chondritic organics, and noble gases trapped during the experiments reproduce the elemental and isotopic fractionations of the primordial noble gas carrier Phase Q observed in primitive organics [1] [5].

These results strongly suggest that both the formation of chondritic refractory organics and the trapping of noble gases took place simultaneously in the ionized areas of the protoplanetary disk, via photon- and/or electron-driven reactions and processing. Thus synthesis of primitive organics might not have required a cold environment and could have occurred anywhere it is ionized in the disk, including in its warm regions. This scenario also supports N_2 photodissociation as the cause of the large nitrogen isotopic range in the solar system [6].

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