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Hypervelocity impact on amino acids embedded in water ice

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Impacts are prevalent in the solar system and have played a profound role in the evolution of the solar system bodies. The delivery of prebiotic compounds through impact events is thought to be a crucial step in developing habitable conditions on a planetary surface. Impact events are, therefore, significant in our understanding of the origins of life on Earth or elsewhere. Previous studies have reported the role of the impact process in the abiotic synthesis of building blocks of life, such as amino acids [1-3] and peptides [4, 5]. Here, we report the results of an experimental investigation simulating hypervelocity impacts in the laboratory on an icy mixture of amino acids. Various batches of amino acid mixtures within water ice targets, mimicking the icy bodies (140 K), were prepared and a spherical bullet of size 1 mm was fired at a speed of approximately 5 km s^{-1} using the light gas gun facility at the University of Kent [6]. Extremely high pressure of 10’s of gigapascals is achieved within a very short time scale as might be expected to be achieved under impact-induced shock conditions. After the impact, the ejected material from the target was collected and analyzed. When these ejecta was subjected to a Scanning Electron Microscope (SEM) analysis, it revealed ordered structures with interesting morphological features. A SEM micrograph of amino acid glutamine ejecta consisting of dendritic patterns is shown in Figure 1. LCMS analysis of ejecta residue shows that long polypeptide is synthesized as a result of impact.

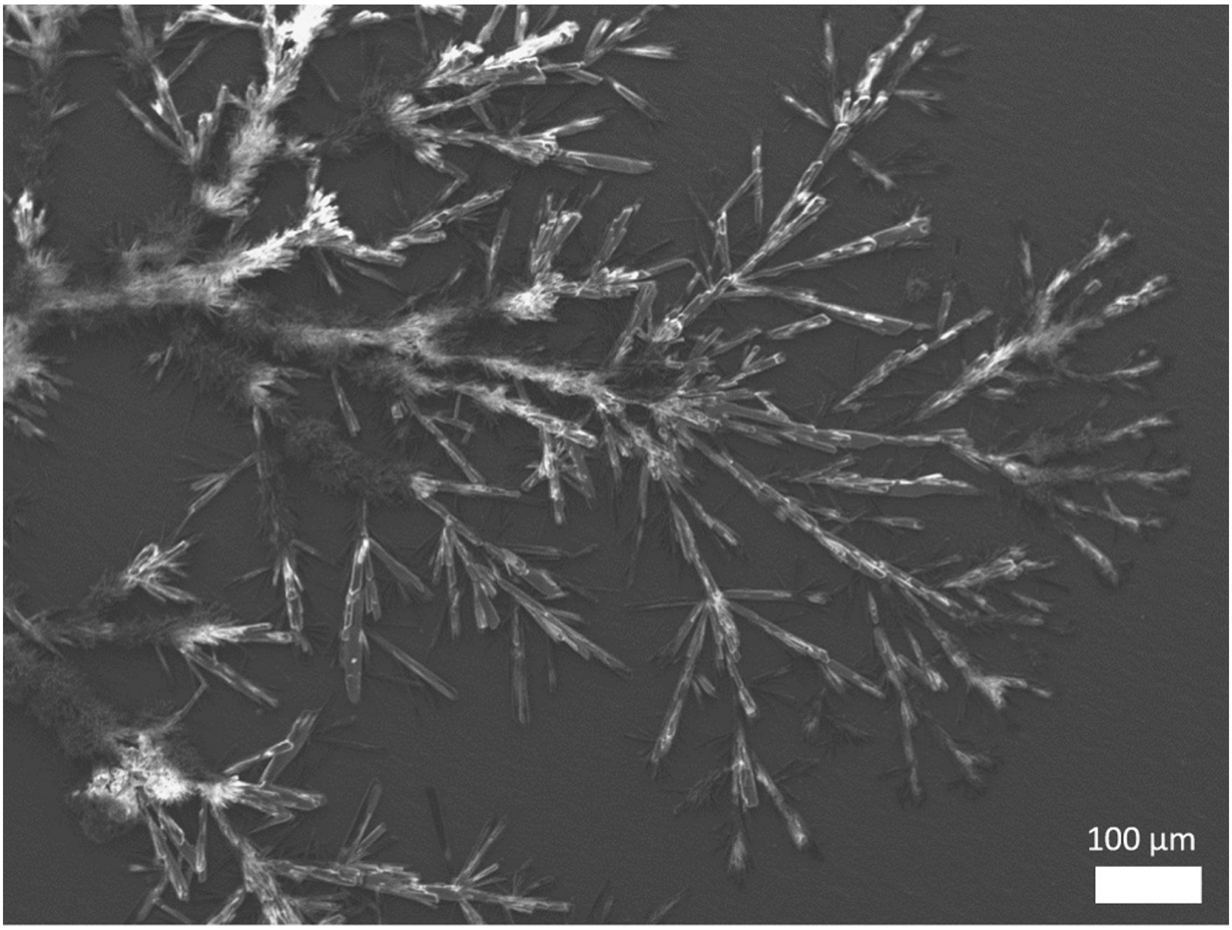

Figure 1 *SEM micrographs of ejecta after impact from glutamine-water ice target shows dendritic patterns with several branching structures.*

The ability of shocked amino acids to form polypeptides assembled in the form of complex macroscale structures provides evidence for the evolution of the building blocks of life under impact-shock conditions. Peptides play a crucial role in the origin of life because of their unique architecture and self-assembling properties [7] and thus, prebiotic availability of peptides is believed to be crucial for the origin of life. The present results provide another step in the elucidation of our understanding of the role played by complex molecules and impact events in the origin of life.

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