Paper ID: 35722
student

MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Specialised Technologies, Including Nanotechnology (8)

Author: Mr. Josh Young
United States

Mr. Wickramaarachchige Lakshantha
United States
Dr. Ara Chutjian
Jet Propulsion Laboratory - California Institute of Technology, United States
Prof. Bibhudutta Rout
United States

SYNTHESIS OF SILICATES ANALOGOUS TO COSMIC DUST USING MULTIPLE ION IMPLANTATIONS

Abstract

This paper discusses a new process for laboratory synthesis of silicates analogous to circumstellar dusts formed by oxygen rich outflows in asymptotic giant branch (AGB) stars. The AGB stars constitutes almost half of the interstellar mass. These silicates are compounds containing a silicon bearing anion (SiO_4^{4-}) along with Fe and Mg. The laboratory synthesis of Mg-Fe rich silicates has recently gained considerable interest due to their need for comparison of physical parameters (structural, compositional and morphological) while analyzing extraterrestrial dust samples. The silicates have been synthesized via laser ablation, vaporization and grinding of natural minerals techniques, which are very complex to understand the diffusion of each element while forming silicate dust analogues. Particularly the Fe–Mg mixed grains need some kind of processing able to supply sufficient energy to overcome the barrier for the diffusion of iron into the magnesium-rich silicate lattice. Irradiation of low energetic ion beam along with thermal-annealing is one of the most attractive processes for synthesis of nanostructured alloys via ion-beam mixing phenomena.

The technical content of the paper includes information on the formation of silicate nano-clusters at near surface-regions. The Si targets were sequentially implanted with O, Mg, and Fe at < 30 keV energies. Prior to the experiment a dynamic ion-solid interaction code is used to simulate the surface sputtering, rise in temperature at molecular-level while the implanted ions are distributed in silicon matrix. The implantation ion doses and annealing temperatures were varied to form various silicate alloys within top-20nm of the substrate. The samples were analyzed for morphology and alloy-phase formation using various surface characterization techniques. The results of this research clarify the growth of silicate minerals in the dynamic conditions near AGB stars. Diffusion of Fe into the Mg-rich silicate lattice will be reported, as it is not fully understood in the context of dust formation. Additionally this research will help gain insight into the fundamental origins of water and complex organic molecules (COMs) necessary for the formation of life, as mediated by dust. The manufactured silicate analogues samples will be used by the Atomic and Molecular Collisions Team of JPL to analyze conditions necessary for water and COM formation upon the dust surfaces, This paper is an original work, written by the student, with oversight from the senior researchers and has not been presented at any previous conferences. This research is performed in collaboration with JPL/Caltech under contract with NASA.