

SILICATE NANOPARTICLES PRODUCED BY LABORATORY SIMULATED SPACE WEATHERING OF OLIVINE SINGLE CRYSTALS. M. Murri¹, G. Capitani¹, M. Fasoli², A. Monguzzi², A. Calloni³, G. Bussetti³, M. Campione¹. ¹ Dept. of Earth and Environmental Sciences, University of Milano - Bicocca, I- 20126 Milano, Italy (mara.murri@unimib.it, marcello.campione@unimib.it), ² Dept. of Materials Science, University of Milano - Bicocca, I-20125 Milano, Italy, ³ Dept. of Physics, Politecnico di Milano, I-20133 Milano, Italy.

Introduction: Silicate nanoparticles, otherwise referred to as very small grains (VSGs) [1], occur in the interstellar medium. These grains experience a strong structural modification during their lifetime in the diffuse interstellar medium, due to events such as grain-grain collisions and irradiation. Grain amorphization is one of the major effects, transforming crystalline dust concentrated in star envelopes into amorphous silicate grains populating the interstellar medium [2]. Moreover, several studies have pointed out that the main building blocks of these silicates are O, Si, Fe, Mg, Al and Ca, all elements that are among the principal constituents of the Earth's surface [3], thus leading to the name "astronomical silicates". However, the structure and chemical evolution together with the origin of these grains are still poorly understood and intensively debated [4,5].

The aim of this study is the simulation of space weathering processes by liquid phase pulsed laser ablation (LP-PLA) on olivine single crystals. We adopt a multiple technique characterization, taking advantage of optical spectroscopy analyses and high-resolution transmission electron microscopy (HR-TEM), to shed light on the structure and chemical evolution of the ablated material.

Materials and Methods: Selected olivine target crystals from the São Miguel island (Azores) were analyzed by Scanning Electron Microscopy (SEM) and Energy Dispersive X-ray spectroscopy (EDX). The resulting olivine composition is around Fo₈₇. Inclusions of plagioclase and ilmenite are also present.

LP-PLA experiments were performed with a Nd:YAG laser focused via a singlet lens onto the surface of the target, which was fixed at the bottom of a polystyrene box filled with 4 ml of deionized water (type 1) to immerse it completely, with the liquid level at ca. 3 mm above it.

Laser pulses of 5 ns and an energy of about 100 mJ, simulate the timeframe and energy exchange occurring during grain-grain interstellar collisions [6]. They generate a plasma plume at the crystal/liquid interface. The rapid cooling induced by the confining liquid layer brings about the condensation of the chemical vapor it contains with production of a colloidal solution of nanoparticles. These solutions were analyzed by optical absorption spectroscopy in the range from 200 nm to 1100 nm (6.20 eV - 1.13 eV).

TEM/EDS analyses were then performed on the ablated nanoparticles deposited from solution directly onto lacy-C-coated Cu grids.

Compositional variations of the ablated target were determined by X-ray photo-emission spectroscopy analyses.

Results and Conclusions: Optical absorption measurements on the ejected material showed a main band around 215 nm. This feature is very similar to the "B2 band" reported in several studies on silica glass [7]. The "B2 band" is often ascribed to oxygen vacancies, but its nature is still far to be fully understood. Moreover, we also found that this feature at 215 nm is very common among both Si and Mg compounds (*e.g.*, Si-oxide, Mg-hydroxide, chrysotile).

TEM/EDS analyses revealed the presence of crystalline nanoparticles (3-5 nm in diameter). These are mainly composed by O, Fe, Si and Mg. Interestingly, the composition of the nanoparticles resulted to be more Fe-enriched with respect to that of the target.

These results suggest that substantial chemical processing might be expected during space weathering of "typical" interstellar grains into VSGs. Moreover, coupling these experimental results with remote sensing datasets will provide fundamental information about the evolution of these silicate grains.

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