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Metal rich Ordinary Chondrites: Near Field analysis and comparison with Finite Integration Technique models

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Introduction

Ordinary Chondrites (OC) are commonly associated to S-type asteroids, since their near infrared spectra are similar. However, asteroids are typically "redder" than OC spectra (i.e. a marked increase of reflectance with increasing wavelength). The reddening of the spectra is believed to be linked to Space Weathering (SW) processes, mainly consisting in micrometeoroids and solar wind particles bombardments of the asteroid surface. One important effect of the SW is the production of submicroscopic metallic iron particles (SMFe), which are responsible for reddening. They can be generated by two processes [1]: solar wind sputtering [2] or shock-induced phase transformation of Fe-Ni alloys caused by microcollisions [3]. The characterization of SMFe in metal rich Ordinary Chondrites can help to understand the role played by the SW in the iron phase transformation of asteroid surface materials.

In this work we applied the SNOM (Scanning Near-field Optical Microscopy) technique, to perform nanoimaging analysis of different OC samples. The analysis were performed at different wavelengths λ and with a high spatial resolution (better than diffraction limit of conventional microscopes, $\lambda/2$) [4].

Scanning Near-field Optical Microscopy (SNOM)

In the SNOM technique, a light beam is passed through an optical fiber, placed very close to the sample surface (some nanometers), used as local illuminator (and/or collector) and with an apical radius of about 100nm. SNOM's tip is moved by piezoelectric motors: in this way it's possible to reconstruct both morphology and optical properties of the sample. Therefore, topographic and reflectivity images at different wavelengths of the sample are obtained. We considered five wavelengths (488, 516, 904, 1300 and 1500 nm) of interest, that include reflectance bands of olivine and pyroxenes, the most important components of OC's. Comparison between SNOM reflectivity images taken at different wavelengths can reveal chemical differences in the sample, for example different mineral phases as silicates and iron nanoparticles.

Synthetic and SNOM images: a comparison

In order to better understand how iron inclusions can change distribution of electric and magnetic energy in the sample we compared SNOM with synthetic images. To produce synthetic images we used a software package that calculates the interaction between the input electromagnetic wave and the sample, solving Maxwell equations in 3D space by means of a Finite Integration Technique (FIT). Three typical planetary materials were considered for the analysis: forsterite, fayalite and enstatite, with and without iron nanoparticles inclusions. In our first application we consider a brief input signal (duration of order of femtoseconds) from a quasi monochromatic source of 904 nm. The analysis of the synthetic and the SNOM images are currently in progress.

References

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