Raman Microspectroscopy of HAYABUSA Particle RA-QD02-0197

U. Böttger (1), C. Alwmark (2), S. Bajt (3), H. Busemann (4), J.D. Gilmour (4), U. Heitmann (5), H.-W. Hübers (1,6), M.M.M. Meier (2), S.G. Pavlov (1), U. Schade (7), N.H. Spring (4), I. Weber (5)
(1) Inst. of Planet. Res., DLR Berlin, Germany (ute.boettger@dlr.de), (2) Dept. of Geol., Univ. of Lund, Sweden, (3) Photon Sciences, DESY, Hamburg, Germany, (4) SEAES, Univ. of Manchester, UK, (5) Inst.f. Planet., WWU Münster, Germany, (6) Techn. Univ. Berlin, Germany, (7) Helmholtz-Zentrum Berlin (HZB), Germany

Abstract

Raman microspectroscopy measurements were performed on Hayabusa sample RA-QD02-0197. The sample has been provided by JAXA to our consortium in the scope of the 1^{st} International Announcement of Opportunity [1]. Raman microspectroscopy is an appropriate technique for a contactless mineralogical investigation and is applied to describe the mineralogical composition of the sample. For the noble gas research proposed in the project [2] it is essential that the sample does not come in contact with the Earth atmosphere. Therefore, the sample has been stored in a container filled with nitrogen and has been investigated through a quartz window. Olivine, pyroxene, and feldspar are the minerals that could be identified.

1. Introduction

The Hayabusa sample return mission was launched in 2003 by the Japan Aerospace Exploration Agency (JAXA). During this space mission material from the S-type, near-Earth asteroid (25143) Itokawa was sampled and returned to Earth. The maximum size of the largest returned samples is below 180 μm [3]. Raman microspectroscopy measurements, which allow for a contactless mineralogical investigation, were performed on Hayabusa sample RA-QD02-0197. This sample is one of seven samples provided by JAXA and was allocated (and remained) in a N2-filled container to avoid Earth atmospheric contamination. The interpretation of the measured Raman spectra indicate that sample#197 mainly consists of Mg-rich olivine. At some measurement points also pyroxene and feldspar could be identified.

2. Sample

The Hayabusa sample #197 is one of three sample that were provided in nitrogen (Figure 1). The size of the sample is about 59 μm. SEM-EDX analysis at the curation facility of JAXA identified olivine and plagioclase mineral phases (JAXA sample documentation).

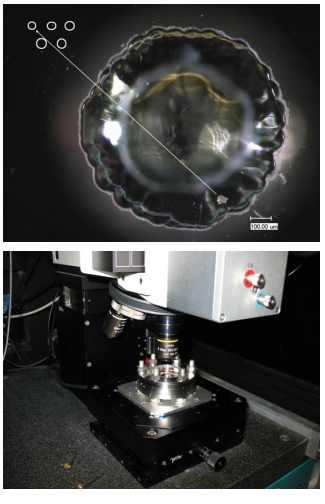

Figure 1: Upper image: Hayabusa sample in the small cavity on the glass slide. Lower image: Modified sample container provided by JAXA under the Raman microscope.

3. Measurements

The Raman measurements were performed through the transparent Quartz glass port that replaced the original JAXA top cover. Single spectra were measured on the sample to identify the minerals. The sample was scanned manually with 44 measurement points (Figure 2) covering the entire sample surface pointing towards the objective. The Raman measurements were carried

out with a Witec Alpha 300 Raman microspectrometer. The laser wavelength was 532 nm. The spectral resolution was about 4 cm^{-1} and for the 10x objective the spot size on the sample was less than 1 μm. The measurement time was 120s and 240s and the power on the sample was 200 μW for each measurement.

4. Results and discussion

In Figure 2, as an example, an averaged Raman spectrum, derived from 10 measurement points (spots 1-10), is presented with an enlargement in the range of the main olivine doublet between approximately 700 till 1000 cm^{-1}. The bands of the doublet were Gauss fitted. The estimated peak positions were compared with two-peak calibration data sets of Kuebler [4]. The derived peak positions indicate Mg-rich olivine (Fig. 2).

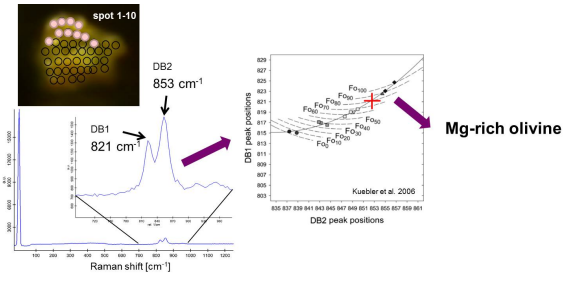

Figure 2: Microscopic image of sample #197 including the 44 measurement points; averaged Raman spectrum of 10 measurement points and comparison with Kuebler et al [4].

In Figure 3 microscopic images and Raman spectra of measurement points number 7 and 33 are shown. Plagioclase has been identified at point number 7 in addition to olivine. The peaks used for identification were around 478 cm^{-1} and 511 cm^{-1}.

At point number 33 olivine and pyroxene could be identified. Here the comparison with literature data [5] indicates high-Ca-pyroxene.

5. Summary and Conclusions

Raman measurements were performed on Hayabusa sample RA-QD02-0197, kept in nitrogen, for contactless mineralogical investigation. Mg-rich olivine, high-Ca-pyroxene, and plagioclase are the identified minerals. The results of the Raman measurements are consistent with an ordinary chondrite of high petrologic type.

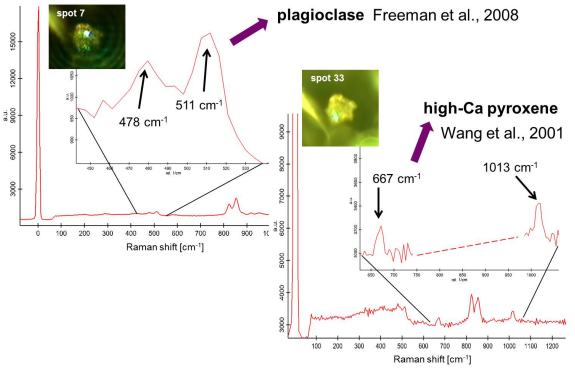

Figure 3: Microscopic images and Raman spectra of measurement point number 7 (left) and measurement point number 33 (right).

Acknowledgements

We thank Dr. Abe and JAXA for the allocation and efficient delivery of the particles.

References

[1] Abe M. et al.: Abstract #5251, *75th Meteoritical Soc. Meeting,* 2012.

[2] Busemann H. et al.: Abstract #2243, *LPSC XLIV*, 2013.

[3] Nakamura T. et al.: *Science 333*, pp 1113-1116, 2011

[4] Kuebler, K. E.: *Geochimica et Cosmochimica Acta 70*, pp 6201-6222, 2006.

[5] Wang, A. et al.: *American Mineralogist 86*, pp 790-806, 2001

[6] Freeman, J.J. et al.: *The Canadian Mineralogist*, Vol. 46, pp 1477-1500, 2008