CHONDRULE FORMATION EXPERIMENT ABOARD THE ISS - FIRST RESULTS. T. E. Koch[1*], D. Spahr[1], D. Merges[1], A. A. Beck[1], O. Christ[1], S. Fujita[1], P.-T. Genzel[1], J. Kerscher[1], M. Lindner[1], D. Mederos Leber[2], B. Winkler[1], F. E. Brenker[1]. [1]Goethe University Frankfurt, Institute of Geoscience, Altenhoeferallee 1, 60438 Frankfurt am Main, Germany, *t.koch@em.uni-frankfurt.de, [2]Goethe University Frankfurt, Department of Physics, Max-von-Laue-Strasse 1, 60438 Frankfurt am Main, Germany.

Introduction: The EXCISS (Experimental Chondrule Formation aboard the International Space Station ISS) experiment was developed to acquire new insights into one of the most enigmatic processes in planetary science — the formation of chondrules. The purpose of the experiment is to investigate if chondrule formation via "nebular lightning" [1–5] is a viable process. At conditions of long-term micro gravity synthetic forsterite (Mg_2SiO_4) dust particles are exposed to electrical discharges with the aim to observe if particles fuse under these conditions. The experiment is carried out inside a 1.5 U NanoRacks NanoLab aboard the ISS (Fig. 1). The experiment was launched with NG-10 on November 17, 2018. After return of the chamber to Earth, we will analyze the experimental products in great detail.

In order to be able to adjust the experimental parameters and to compare the results we will obtain from the experiment in micro gravity, we currently also perform fusion experiments in our lab on Earth.

Here we present details of the experimental setup as well as the first preliminary results based on data downloaded from the International Space Station ISS together with results from our ground based experiments.

Experimental Details: In the experiment aboard the ISS, well characterized olivine dust particles with grain sizes between 80–120 μm are levitating between two W-electrodes in an optically transparent glass sample chamber, filled with Ar at 100 mbar pressure, where they can be subjected to electric arcs.

The limitation of the available space made the implementation of this experiment challenging, especially with respect to the generation of high energetic lightning and the integration of an optical recording system. An appropriate circuit was designed in which a DC-DC converter is used to charge three 150 uF capacitors up to 550 V. After triggering by a high voltage peak generated from an ignition coil causing an ignition spark, the stored energy is released into an arc discharge.

The experimental process aboard the ISS is separated in two different stages. In the first stage of the experiment we observe the behavior of the dust particles while moderate electrical voltages below those required for discharges are applied. We also induced ignition sparks in order to define the experimental conditions for the fusion experiment. This phase has been already completed. The second stage of the experiment which includes the high energy arc discharges are currently being carried out.

On Earth, we used a similar experimental setup to fuse dust particles at the same pressure conditions. We characterized the starting material and the products of the Earth based experiments by X-ray diffraction, scanning electron microscopy, Raman spectroscopy and synchrotron micro-tomography.

Results: The video material received from the ISS showed that some dust particles initially stuck on the walls and the electrodes. More interesting, most of the particles form an irregular shaped agglomerate levitating in the sample chamber (Fig. 2). This agglomerate is attracted by the charged electrodes. The agglomerate disintegrates when an ignition spark is generated, but shortly afterwards the dust particles agglomerate again.

Discussion: The overall structure and the high amount of pores of the agglomerates resembles that of amoeboid olivine aggregates (AOA) present in many primitive meteorites [6], although the mean agglomerate sizes is about 10 times higher. The video material also reveals that the dust particles favor being connected to other dust particles rather than to the electrodes. A quantitative analysis of this behavior and its origin is currently being carried out.

Outlook: High energy arc discharge experiments are scheduled for January 2019 in order to fuse the dust particle agglomerates to demonstrate chondrule formation in electric discharges in microgravity. The capsule return is planned with SpaceX flight CRS17 scheduled for April 2019.

References:

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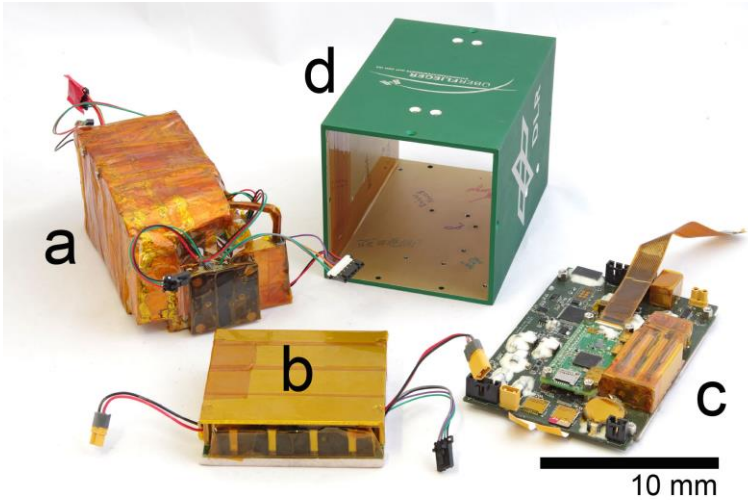

Fig. 1: Experimental setup with high voltage electronics, optics and sample chamber (a) power supply unit (b) control unit (c), and the NanoRacks NanoLab enclosure (d).

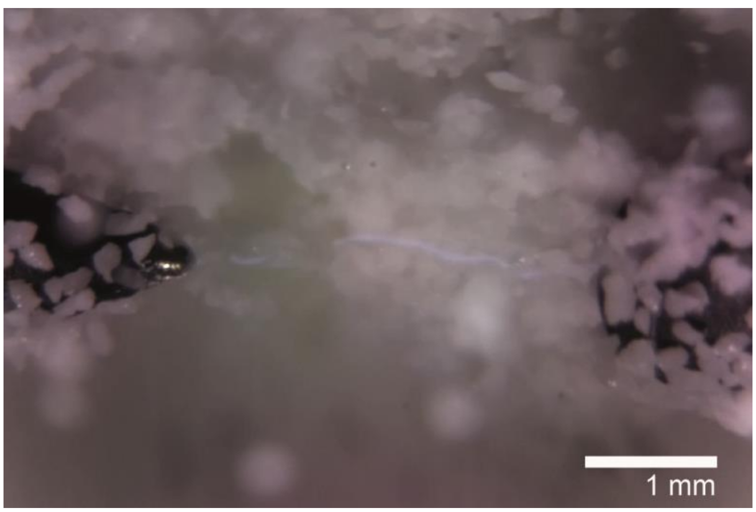

Fig. 2: View inside the sample chamber aboard the ISS during a low energy ignition spark. W-electrodes are shown on the right and left hand side.