EXCISS, A 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[1], F. Wilde[2], W. Morgenroth[1], B. Winkler[1], F. E. Brenker[1]. [1]Goethe University Frankfurt, Institute of Geoscience, Germany. [2]Helmholtz-Zentrum Geesthacht, HZG Outstation at DESY, Hamburg, Germany.
*t.koch@em.uni-frankfurt.de

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 caused by "nebular lightning" [1–5] is a viable process. Synthetic forsterite (Mg_2SiO_4) dust particles are exposed to electrical discharges at conditions of long-term micro gravity with the aim to observe if particles fuse and/or form chondrule-like objects under this conditions. The experiment is carried out inside a 1.5 U NanoRacks NanoLab aboard the ISS. 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 adjust the experimental parameters and to compare the results, we performed 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 Earth-based experiments.

Experimental Details: In the experiment aboard the ISS, well characterized olivine dust particles with grain sizes between 80–120 µm were levitating between two W-electrodes in an optically transparent glass sample chamber, filled with Ar at 100 mbar pressure, where they could 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 being triggered by a high voltage peak generated from an ignition coil causing an ignition spark, the stored energy was released into an arc discharge.

In the first stage of the experiment aboard the ISS we observed the behavior of the dust particles while moderate electrical voltages below those required for discharges were applied. We also induced ignition sparks in order to define the experimental conditions for the fusion experiment. The second stage of the experiment included high energy arc discharges.

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 formed an irregular shaped agglomerate levitating in the sample chamber. This agglomerate was attracted by the charged electrodes. The agglomerate disintegrated when an ignition spark was generated, but shortly afterwards the dust particles agglomerated again. High energy arc discharge experiments led to changes in the particles.

Discussion: The overall structure and the high amount of pores of the agglomerates resemble 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 revealed 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 as well as an analysis of the particle changes.

Outlook: The capsule return is planned with SpaceX flight CRS17 scheduled for end of May 2019.

References: [1] Whipple F. L. (1966) Science 153:54–56. [2] Horányi, M. et al. (1995) Icarus 114:174–185. [3] Desch S. J. and Cuzzi, J. N. (2000) Icarus 143:87–105. [4] Johansen A. and Okuzumi A. (2018) Astronomy & Astrophysics A31:1–22. [5] Güttler C. et al. (2008) Icarus, 195:504–510. [6] Krot A. N. et al. (2004) Geochemistry 64: 185–239.

Acknowledgments: The experiment is supported by the German Aerospace Center DLR together DreamUp and NanoRacks LLC. We also thank the Dr. Rolf M. Schwiete Stiftung and the BMWi for financial support. Further thanks goes to our sponsors BIOVIA and ZEISS. A special thanks goes to the Hackerspace Ffm e.V..