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First results from the MIDAS force-curve measurements

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1 Introduction

The Micro-Imaging Dust Analysis System (MIDAS) was the first AFM launched into space onboard the Rosetta spacecraft. The MIDAS instrument producing the highest resolution 3D images of cometary dust ever made in situ by using the dynamic mode of the AFM. These images were already used to determine the grain size and porosity of cometary dust particles [1, 2]. In addition to the dynamic mode, the AFM was also operated in the contact mode (see Fig. 1) in which the cometary dust particles were touched by the cantilever tip. This mode allows the measurement of force curves, which can be used to derive the hardness and the particle size of the cometary dust.

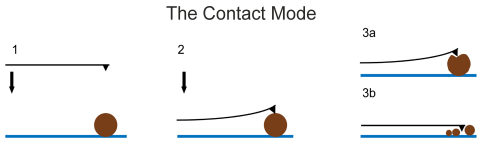

Figure 1: Contact mode of the MIDAS AFM. First, the caantilever is lowered until it touches a particle (1). Then, the cantilever starts to bend and the measured force increases (2). Possible particle reactions on contact stress are: elastic indentation of the cantilever into the particle (3a), or disintegration of the particle (3b).

2 Force Curves

With the movement of the cantilever, controlled by a step motor, the position with respect to the target's surface was derived. Additionally, the resulting force was continuously monitored by the bending of the cantilever. When in contact with a dust particle, the cantilever starts to bend and a contact stress is exerted on the particle. An example for a typical force curve is shown in in Fig. 2.

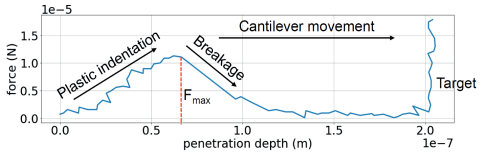

Figure 2: Typical force curved measured by the MIDAS AFM. The cantilever approaches from the left and the target surface is located on the right in this plot. From the shape of the force curves it is possible to derive how many particles were penetrated by the tip of the cantilever. In this example only one particle was indented.

3 Pressure Curves

Pressure curves are derived from the force curves by exactly knowing the geometry of the tip (as the tips's cross section is required for the pressure estimation). Fig. 3 shows a SEM image of a MIDAS cantilever and tip that was used for the contact mode measurements. The resulting pressure curve is presented in Fig. 4.

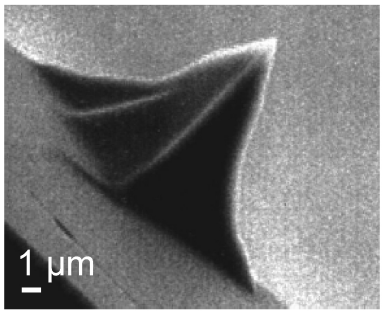

Figure 3: SEM image of a MIDAS tip that was used for the contact mode measurements.

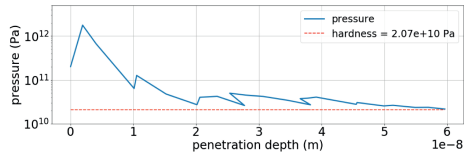

Figure 4: Pressure curve derived from Fig. 2. From the pressure curve the hardness of the material can be derived (red dashed line)

4 Hardness of Cometary Dust

From the pressure curves it is possible to derive the hardness and the particle size of the cometary dust particles. Details of the data analysis and AFM measurements with analogue materials will be presented during the EPSC conference.

Acknowledgements

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