EXPERIMENTS ON PLANETESIMAL FORMATION WITH TEMPERED DUST.

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Introduction: The temperatures in the Solar Nebula span a wide range. Depending on the location within our protoplanetary disk, temperatures ranged from freezing cold few degrees in the outer regions to beyond 2000 K close to the young sun. Condensation sequences are often considered to be important to describe the composition of solids [1]. The local composition of dust might vary significantly though during evolution of the disk as mixing of different materials was frequent. Eventually, such mixed dust might drift inward again [2]. As example, chondritic porous IDPs from the outer disk might be contributing to the formation of Mercury in the inner disk as suggested by Ebel et al. [3]. However, as the first phases of planet formation are based on sticking collisions of dust particles it might be asked how the stickiness of inward drifting dust aggregates changes due to being subjected to elevated temperatures. A potential change in sticking has two components: 1) At temperatures close to a sublimation front dust might become more sticky due to viscosity effects. This is not studied here. 2) The different minerals within the dust might change composition already at moderate temperatures. This will influence sticking due to the new composition, changes in particle sizes and morphological changes. This is studied here.

Experiments with Tempered Dust: We used the martian analog dust JSC Mars 1a as a first mineral mixture to test the idea of changing sticking properties. The samples were heated (in air) to different temperatures up to 1600 K for 1h and at 1000 K for different durations up to 200h. Afterwards we measured the tensile strength of each dust sample. We developed a new technique for tensile strength measurements where thermal creep induced overpressure within an illuminated dust sample at low ambient pressure leads to dust ejections. We find an increase in tensile strength (sticking) by a factor of 3 above 800 K. At this temperature we also measured the onset of a change of the iron bearing minerals (iron oxides, pyroxenes and olivines) towards hematite by Mössbauer spectroscopy and SQUID magnetometry. Also at the same temperature the minimum particle size in the sample starts to increase from 1.4 µm at 800 K to 2.8 µm at 1200 K. Last not least at 800 K we find a significant fracturing of large individual grains.

Conclusion: The used mixture of materials shows significant transformations already at rather moderate temperatures of 800 K. This strongly increases the stickiness or tensile strength of a dust sample. We cannot pin down one reason for this unambiguously. It might be the composition, particle size distribution or morphology of the grains. All are usually considered to be important for sticking. In any case, a factor of 3 estimated as minimum increase of the sticking capability at a certain temperature is not negligible. It should lead to an increased formation of larger aggregates above a threshold temperature or inside a certain distance to the sun and influence the formation of planetesimals [4].

References: [1] Ebel D. S. 2006. in: *Meteorites and the Early Solar System II* (ed. Lauretta, D. S. and McSween Jr. H. Y.), Univ. Ariz. Press, Tucson, p.253-277. [2] Weidenschilling S. 1977. *Monthly Notices of the Royal Astronomical Society* 180:57-70. [3] Ebel D. S. and Alexander, C. M. O. 2011. *Planetary and Space Science* 59:1888-1849. [4] De Beule, C. et al. (submitted). *Astrophysical Journal*.