Planetesimal growth through collisions? Yes we can! J. Teiser[1] and G. Wurm[1], [1]Institut für Planetologie, Universität Münster, Wilhelm-Klemm-Str. 10, D-48149 Münster, Germany, j.teiser@uni-muenster.de.

Introduction: The formation of planetary precursors via coagulation of dust aggregates in mutual collisions is a widely accepted model for the first growth phase of the Solar System. In this scenario dust grains condensed from the gas phase and agglomerate to larger aggregates. In the simple picture collisions continue and lead to the formation of (km-size) planetesimals. Gravitational attraction gets significant at this point. Within this work I describe the coagulation scenario for planetesimal formation from the experimental perspective.

Disk models: Several authors developed models describing the dynamics of gas and solid particles for the Solar Nebula at different solar distances [e.g. 1, 2]. Depending on the particle sizes, the relative motion between particles is driven by different mechanisms. For small (<100 µm) particles Brownian motion is the driving mechanism. With increasing sizes, vertical settling towards the midplane due to gravity, radial drift due to gas drag, and possibly turbulence become more and more important. Depending on the disk model and the particle sizes, velocities between colliding aggregates range from mm/s (µm particles) to more than 60 m/s (m-size bodies, [1]).

Experiments on coagulation: Several studies investigated aggregate collisions in the different parameter regimes.

Collisions between µm-size particles with low impact velocities (Brownian motion) were investigated by [e.g. 3, 4]. They found that in this parameter range collisions show a hit-and-stick behavior and lead to a fast growth of fractal aggregates.

Experiments by [5] showed, that with increasing velocities, collisions still lead to direct sticking. However, fractal agglomerates are compacted to non-fractal, but highly porous aggregates, eventually.

Experiments with equal sized (>mm) dust agglomerates showed, that particles either bounce off each other (v < 1 m/s) or break up into smaller fragments for larger velocities [6, 7]. For larger size differences, collisions can lead to sticking in the same velocity range (v > 1 m/s), if the smaller particle can intrude deeply enough into the surface of the larger body [8].

Collisions in this velocity range lead to compression of the collision partners [e.g. 9]. This reduces the probability of collisional growth, but does not prevent it. Experiments with small (~100 µm) particles hitting a large compact body (>> 1 cm) with velocities of 8 m/s showed, that larger aggregates form and are highly compressed with a volume filling of 31% [10]. In this parameter range direct sticking was observed as well as reaccretion of ejecta due to gravity. Drifting aggregates feel a headwind within the Solar Nebula with gas drag being of the same order as gravity in laboratory experiments.

Experiments with still higher impact velocities showed, that fragmentation is an important process for collisional growth. For impact velocities higher than 13 m/s, a great part of the projectile's energy is dissipated by fragmentation and part of its mass directly sticks to the target [11]. With increasing collision velocities (up to 60 m/s) impacting particles have to be small to get accreted by this process [12].

We will detail these experiments in the workshop. Putting emphasis on the latest results, open issues and possible solutions we will construct one possible scenario for planetesimal formation by collisional growth.

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