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Plasma Surface Modification of Powders – Influence of the Particle Size

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Many products and intermediates in chemical, pharmaceutical or food industry exist in the form of powders. The handling performance of such powders strongly depends on wettability, flowability and compactibility of the particles. These properties of the microscopic particles can be changed by plasma-induced surface modification. For this, the powders are treated in an RF-plasma down-stream reactor (PDR) which provides fast and homogeneous treatment of the particle surface. Nanoparticles are generated by favouring homogenous gas-phase reactions in the plasma and are simultaneously attached to the surface of the substrate particles. The nanoparticles act as spacers between the substrate particles and thereby improve the powder flowability as the attractive interparticle Van der Waals forces are reduced.
It is generally stated that bigger particles have a better flow behaviour compared to smaller particles of the same chemical composition and shape. On the other hand, it is not obvious if the deposition process is equally effective for all particle sizes in the PDR. Although the process is used for different products with varying particle size distributions, the influence of the particle size on the process and on the finally reached flow factor was never studied in detail before. Within the scope of this study the powder is fractionated according to the particle size. Then the different fractions are individually processed in the PDR. The treatment based on the attachment of SiO_x nanoparticles to the surface of the particles of the different powder fractions is studied experimentally and explanations of the found effects are provided.
As the plasma treatment of very fine substrate particles (below 5 µm) requires special reactor concepts and adequate separation units, first of all the key elements of the amended plasma down-stream reactor will be introduced. The flow factor of every powder fraction is measured in a ring shear-tester before and after the treatment in order to quantify the particle size dependent improvement of the powder flow behaviour. High resolution scanning electron micrographs are taken to support these measurements and to further characterize the nanoscale functionalization of the particle surfaces.

Keywords
Particle surface modification
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Plasma down-stream reactor
Nanoparticle deposition
Particle size distribution