Preparation of SiO_2 agglomerated particles

Nano Spray Dryer B-90 HP:
Nano spray drying as an innovative tool for material sciences

1. Introduction

Nanoparticles are attracting a lot of attention in several industry applications such as ceramic material [1], atmospheric plasma spray (APS) coating [2], drug formulation [3, 4] or drug delivery system [5]. Their small size makes them challenging to handle and can represent a risk for the health of the personnel using such powders [2, 6]. Agglomerating the nanoparticles is necessary to overcome the previously mentioned issue [2, 6]. Free-flowing, spherical particles with uniform morphology and narrow size distribution are highly desirable for many applications and can easily be obtained by spray drying. For applications in ceramic material or drug formulation for example, a compression of the agglomerate material is necessary.t. The properties of the agglomerated material will largely determine the compaction behavior of the powder and the uniformity of the final product [1, 3].

Spray drying is an established method to produce granulated material by converting a liquid (i.e. solution, emulsion, dispersion or suspension) into solid spherical particles with precise specifications [1, 3, 6]. If the used suspension consists of nanoparticles, the resulting agglomerated particles comprise nanoparticles to forming nanostructured powder in the sub-micrometer / micrometer size range [6]. Through this approach, the properties of nanoscale particles are preserved into micrometer scale particles which are easier and safer to handle [7].

Due to its chemical and physical properties, silica is an advanced material widely used in a variety of applications such as ceramic production, drug formulation or drug delivery [3, 5, 6]. Here, silica was chosen as a model suspension material to investigate the feasibility to agglomerate nanoparticles using the Nano Spray Dryer B-90 HP.

2. Experimental and Results

The application study demonstrated the feasibility to agglomerate a suspension of silicon dioxide with the Nano Spray Dryer B-90 HP. The scanning electron microscope (SEM) pictures of the dried powders in Figure 1 show that the agglomerates have a spherical structure with a diameter from 0.372 to 4.02 um can be obtained with recovery yields above 60 %. When PVA is used as a binder, the sphericity and the density of the particles seem to be increased and the agglomeration more efficient. After removing the binder by heating, more porous particles can be observed. Burning the binder does not influence the particle size.

During the spray drying process, it was observed that the suspension consumption tends to slow down with time; yet, the decrease in throughput does not seem to depend on the composition of the suspension. This result is probably due to spray head clogging with particles.

Despite the detected decrease in throughput, total clogging of the head was not reached through these experiments and it was possible to spray dry up to 200 mL of a 1 % SiO_2, 0.05 % PVA suspension without any total blockage of the nebulizer. Averaged throughput were comprised between 9 mL/h and 13 mL/h for the reported spray drying processes.

In order to confirm binder removal through the burnout process, SEM pictures (Figure 1) and weight measurement have been used.

Visual analysis of the pictures (Figure 1) tentatively confirms binder removal since the particles seem to show a higher porosity after burnout of the PVA binder.

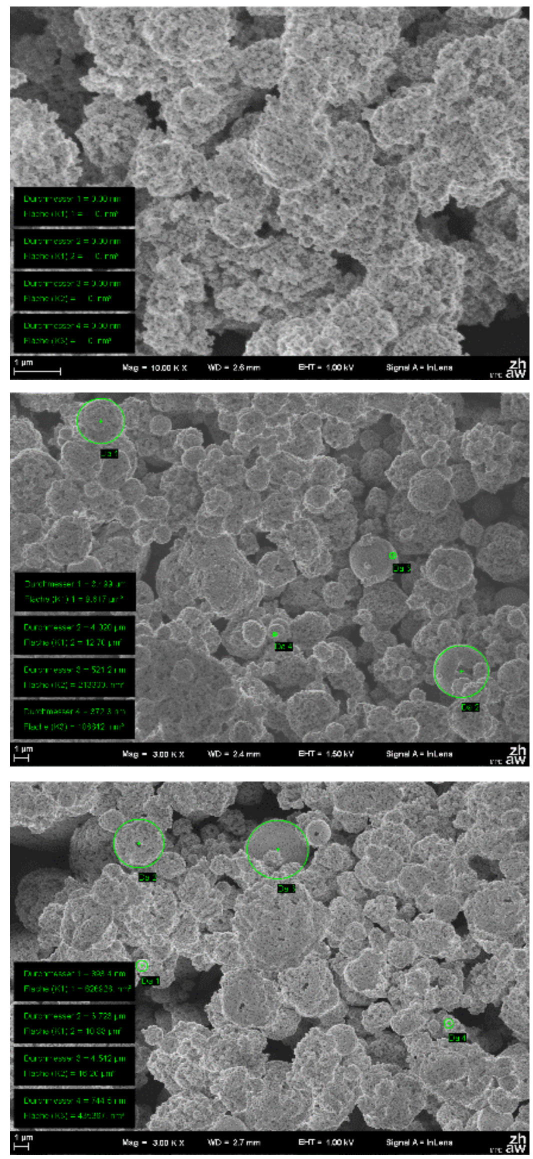

Figure 1 : downwards, SEM pictures of the agglomerated SiO2 powder without binder, with 0.05 % PVA as a binder before and after burnout.

3. Conclusion

SiO_2 was successfully spray dried using the Nano Spray Dryer B-90 HP. Aggregates were obtained with and without the help of a binder. The Wet Digester B-440 was used to burnout the binder after the spray drying process.

Particles produced with the help of PVA as a binder were more spherical than the simple agglomerates, moreover, the porosity of the particles increased after the burnout process.

4. References

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