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Powder functionalization and coating with an atmospheric pressure plasma jet

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Tailoring the surface properties of micro- and nanoparticles without changing the bulk material can increase not only the number of possible applications; it can also improve the properties of the product in which the particles are incorporated. Surface modifications such as functionalization or coating can affect several properties such as wettability, corrosion resistance, surface passivation, surface roughness, dispersion, flowability, physical and chemical stability. In this way high added value particles can be created.
Dielectric barrier discharges (DBD) at atmospheric pressure can be used for surface modification. This technique limits the use of chemical solvents and is therefore environment-friendly. Moreover, it is relatively cheap compared with vacuum plasma technology and it can be integrated in a continuous production process. Finally, because it is a cold plasma surface engineering technique, it enables the treatment of temperature sensitive materials.
In this work, a DBD plasma is used for functionalization and coating of powder particles. Therefore, the PlasmaSpot® reactor is redesigned to treat micro-and nanoparticles. The PlasmaSpot® is a cold atmospheric pressure plasma jet in which a dielectric barrier discharge is created. Powder is added to the N_2-plasma gas flow and a liquid precursor can be added in the afterglow for coating possibilities.
Functionalization in the PlasmaSpot® is demonstrated on polyethylene powder. After a treatment time of only 30 ms, the dispersion behavior of the PE powder in water increases drastically. The effect of the plasma treatment is further evaluated through XPS and contact angle measurements.
The coating capabilities of the reactor are validated on ZrO_2 beads. These beads are perfectly spherical and therefore good candidates to visualize a coating. A liquid precursor APEO is added in the plasma afterglow of the PlasmaSpot® reactor. XPS, SEM and TEM analyses show a non-uniform coating in terms of thickness and distribution across the particle surface.

Keywords
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