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Editorial: Dry powder coating in manufacturing processes

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Editorial on the Research Topic
Dry powder coating in manufacturing processes

Dry powder coating is becoming increasingly prevalent, whereby larger ‘host’ particles are coated by many fine ‘guest’ particles in order to improve the properties of the product. The most common application for dry powder coating is to improve the flowability of the host powder, most often by coating with nano silica. Kleinschmidt et al. explore the viability of ‘clean-label’ flow additives, such as milk powders, maltodextrin and lactose, for replacing silica in food powder products. They show that all lead to an improvement in powder flowability, with particle size being the dominant factor on flow improvement, and the specific material effect being negligible amongst the clean-label additives. The clean-label additive mixtures mostly reached the easy-flowing classification, in contrast to the free-flowing performance offered by coating with aerosil. Interestingly, extrapolation of the flow classification against guest particle size suggests aerosil still outperforms the clean-label additives in terms of flow improvement.

Goh et al. explore a different application of dry powder coating, with the guest acting as an anti-static agent. They show that at a low mass fraction of guest material, for all three tested aluminium stearates the electrostatic charging tendency against all tested surfaces is reduced when coating acid-washed glass beads. In contrast, when the glass beads are silanised prior to coating the charging propensity does not improve for any of the aluminium stearates. Increasing the mass fraction of the guest results in more extensive charging for all particle combinations, demonstrating the complexity of the product performance and the likelihood of an optimum extent of surface coverage.

Schmidt and Peukert review dry powder coating for additive manufacturing applications. Polymer powders often exhibit poor spreadability due to cohesion and electrostatic charging, so dry powder coating is sometimes used as an anti-static agent and sometimes as a flow promoter. Coating with hydrophobic silica has been shown to improve spreadability, whereas coating with hydrophilic silica leads to high atmospheric moisture absorption, resulting in a difficulty to disperse formed nano agglomerates and therefore poor spreadability. Plasma enhanced fluidised bed coating significantly improved the flowability over dry coating, enabling a 5-fold reduction in guest mass fraction–attributed to the much improved rupture of agglomerates. In contrast to polymers, flow improvement is often not needed for metal powders due to their relatively low bond number because of their high density, however dry powder coating has been applied to enable functionalized parts, such as magnetic or electrically conductive devices, and also to improve absorptivity.

Martin-Salvador et al. apply CFD-DEM simulations to a plasma enhanced fluidised bed coating process. They demonstrate that at low fluidisation rates the coating is unreliable, with a large fraction uncoated and a higher coefficient of variation of coating mass. At increasing fluidisation velocity the average coating mass decreases, however the coating is more evenly distributed. The coating mass is normally distributed across the host powders at increased time, with the coefficient of variation reducing as a square root of time. The authors also demonstrate reliable extrapolation of the simulation to longer coating times.

Khala et al. use DEM simulations to develop a regime map for dry powder coating in a small-scale agitated mixer. The harmonic mean of the granular bond number is shown to represent the influence of material properties on coating performance, whilst the Stokes' deformation number dictates the influence of process parameters. The map hypothesises that a threshold Bond number is required to ensure guests stick to the hosts, with a threshold Stokes' deformation number required to ensure the guest agglomerates are well dispersed and distributed across the host surfaces.

Collectively these works demonstrate the diverse applications of dry powder coating and technologies used to apply it. They reveal the complexity of the interactions of guest and host, depending on material properties (size distribution, density, surface energy, charge tendency, etc.) and process parameters (mixer type, energy input, time, guest mass fraction, etc.). They also shed light on various systems in which dry powder coating has been applied, and show there is still much to be done in this field to develop a fully predictive approach, whereby desirable product properties can be achieved by direct application of known operational conditions.

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Conflict of interest

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