Powder coating coverage of sharp edges before curing

Depending on the geometry of the object to be coated, keeping the tolerance window can be a technical challenge. During the application, powder particles are significantly influenced by three physical effects, namely electrostatics, aerodynamics and gravity. The effects of electrostatic forces and gravity can be imagined at ease, while physics gets complicated in interaction with aerodynamics. The coating of sharp edges can lead to unexpected effects, as illustrated in this article.

Nils Reinke, co-CEO coatmaster AG

Powder coatings are increasingly popular due to their advantageous mechanical properties and solvent-free application. Powder coatings not only give surfaces a high-quality appearance but also functional properties. The most important functional properties include protection against corrosion and electrical insulation. However, a powder coating can only fulfill these properties if the thickness of the coating does not exceed or fall below a given tolerance window.

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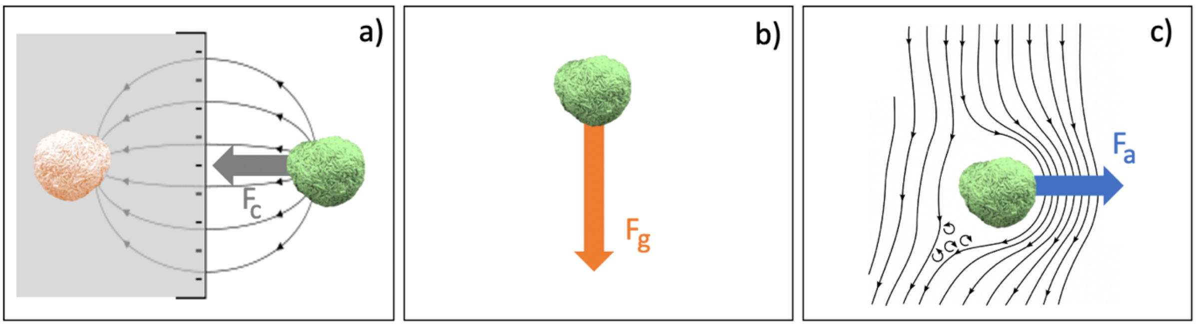
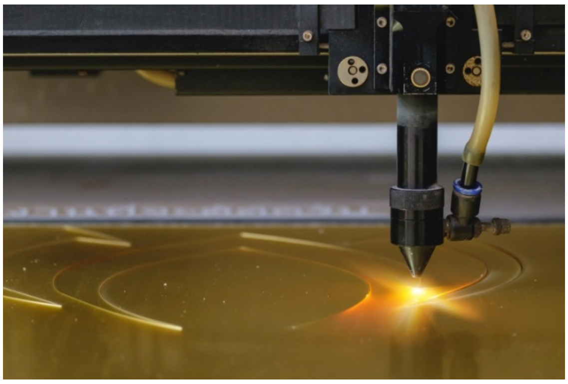


1 The dominant physical effects in powder coating include a) the electrostatic force, b) the gravitational force and c) the aerodynamic force.

Sharp edges are considered to be weak spots for corrosion protection and electrical insulation even after coating. The weak points arise because the necessary coating thickness cannot be built upon sharp edges. Sharp edges are typically created by trimming sheet metal or laser cutting. An effective counter-measure is the rounding of sharp edges by blasting or grinding. One effect that can lead to the thickness falling below the specified minimum is the shrinkage of coatings at edges. Here, the coating material flows away from the edge-driven by the surface tension after softening at elevated temperatures. In the region of the curvature, the coating thickness thus decreases and a greasy edge is formed in the area around it.



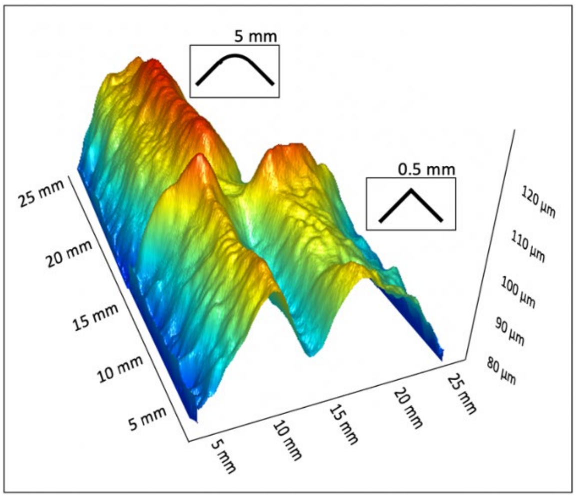
2 Sharp edges, which occur during laser cutting of sheet metal parts, should be rounded off by suitable measures before coating.

New investigations show that the layer thickness on the edge before baking can be lower than generally assumed. In an experiment, two profiles with two different radii of curvature (5mm and 500µm) are powder coated at the same time (RAL 2008, smooth finish).

The powder gun is located at a distance of 50 cm from the object, at a high voltage of 50kV and a conveying air of xx l/min. After powder coating, the layer thickness distribution is measured with a coatmaster 3D before baking. The measured image section is 25 mm x 25 mm, with a spatial resolution of 100µm.

The rear part of Figure 3 shows the layer thickness distribution over a radius of curvature of 5mm. The coating thickness on the edge is about 40% higher than on the flanks of the profile. A different situation is observed on profiles with a sharp radius of curvature of 500µm. Here, the coating thickness directly on the edge is about 20% below the thickness of the surrounding area.

The increased coating thickness on the rounded edge can be attributed to the electrostatic effect between the powder gun and the earthed component.



3 Coating thickness distribution on profiles with different radii of curvature recorded with a coatmaster 3D atline

Electrically charged powder particles are accelerated along electric field lines to edges and are deposited there. To explain the reduced layer thickness on the sharp edge, the predominant aerodynamic forces must be considered in addition to the electrostatic forces. When the air flows around sharp edges, the flow detaches itself and a pronounced area of low pressure is formed. According to Bernoulli, this is associated with a considerable increase in speed at the edge. In the vicinity of sharp edges, flow forces, therefore, outweigh electrostatic forces and powder particles do not settle.

In addition to edge alignment, fluid mechanics is a major cause of the formation of weak spots in powder coating for corrosion protection and electrical insulation. In an ongoing research project to optimize the flow properties of functional powder coatings, it is considered that coating material can flow both away from the edge (classical edge alignment) and towards the edge (edge feed). Imaging coating thickness measurement has a very important role in the development of coating materials with improved edge coverage that allow improved protection against corrosion and electrical isolation.

Author

Prof. Dr. N. A. Reinke
co-founder, co-CEO
coatmaster AG
CH-Winterthur
Tel. +41 52 2120277
info@coatmaster.com
www.coatmaster.com