

THERMASPRAY

Myth Buster 2

“Thermal spray coatings always chip off”

One frequently encounters the statement in industry that customers are apprehensive to use thermal spray coatings because experience with thermal spray coatings were that the coatings **always** chipped off. The adhesion of thermal sprayed coatings has been a primary concern in industry ever since the processes were introduced because thermal spray coatings are not metallurgically bonded to the substrate as in the case of welds, but is mechanically bonded.

During the early years of the thermal spray technology and the use of thermal spray processes such as arc and flame spray, the limiting factor had been inadequate bond strength between the coating and substrate leading to delamination or peeling of the coating especially coatings experiencing high shear stresses such as wear rings, bushings and sleeves mainly due to the thermal spray application process. A major factor seen in earlier coatings, and unfortunately still seen today, is poorly prepared surfaces which will inevitably lead to lack of adhesion and thus coating separation.

However, thermal spray for example, has made such rapid advancements (in the form of the High Velocity Oxy Fuel system) since then, that the bond strength of the coating to the substrate now exceeds the bond strength of most epoxy adhesives used during the adhesion testing of these coatings.

The HVOF coatings of today are successfully applied to a variety of substrates and typically exhibit higher densities, superior bond strengths (typically >80 MPa) and less decarburisation than many of the other thermal spray processes due to the HVOF process having higher particle impact velocities and relatively low peak particle temperatures.

Coating adhesion strength (defined as the bonding between the coating and the substrate) and the coating microstructure are both strongly influenced by the residual stresses present in a coating. The level of residual stress can change the coating substrate interface significantly and create delamination

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that can lead to spallation. Compressive residual stresses at the interface inhibit the formation of through-thickness cracks and improve adhesion bonding and fatigue strength. The adequate bonding of the coating is extremely important for the use of thermal spray coatings in engineering applications and all factors that affect the adhesion of a thermal spray coating has to be identified and controlled to ensure the adhesion strength of the thermal spray coating.

The adhesion of the coating is not solely dependent on the coating-substrate interface, but also on the bonding between the spray particles. The two main types of coating failure are cracking and de-bonding. The characterisation of thermal spray coatings through the use of measurement methods like the adhesion test (in accordance with EN 582 / ASTM C633) and the micro indentation test (Figure 1) defines coating quality.



Figure 1: Adhesion samples in testing configuration

The influence of the base material as well as the degree of surface roughness prior to thermal spraying should be evaluated together with the testing for the adhesion strength of the coatings in order to obtain a complete picture of the adhesion of thermal spray coatings.

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Surface contaminants, especially for HVOF coatings, are too responsible for low bond strength. Factors such as residual stresses due to incorrect spraying parameters (insufficient pre-heat, excessive inter-pass temperature, excessive deposition rates) improper sized powder or improper/over grit blasting can all contribute to the decrease in the adhesion strength of thermal spray coatings.

The importance of proper surface preparation and adequate thermal spray process control cannot be over emphasised. Although it was observed that for HVOF coatings, surface contamination might not be the largest factor, good practice in thermal spraying is to ensure that surface contamination is prevented and adequate process control is maintained during the thermal spraying process. Applying the coating within a short period of time (30 minutes) after grit blasting eliminates the formation of early corrosion / moisture on the substrate to be coated.

Conclusion:

A skilled operator will ensure that both surface preparation and coating application is done in a manner that will guarantee that the thermally sprayed coating does not chip off. If one thus experiences this in an application, the supplier of the thermal spray service's quality would need to be questioned.

References:

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