# GOOD VS BAD COATINGS

A coating is produced by a process in which molten or softened particles are applied by impact onto a substrate. A common feature of all thermal spray coatings is their lenticular or lamellar grain structure resulting from the rapid solidification of small globules, flattened from striking a cold surface at high velocities.

Several key processing steps are required to produce optimal thermal sprayed coatings. To ensure adequate bonding of a coating material, the substrate must be properly prepared. The substrate surface must be clean and roughened after cleaning, usually by grit blasting. Masking and heating are commonly applied to the substrate prior to thermal spraying. Coating quality also depends on spray process variables such as part temperature control, gun and substrate motion, spray pattern, deposition efficiency and deposition rate. Post-coating operations further enhance the quality of the coatings. These include finishing treatments such as grinding and polishing, densification treatments such as fusion, and testing and inspection.

The microstructure of a thermally sprayed coating is characterised by the existence of various pores, micro-cracks, splat boundaries, oxides, grit entrapment, and unmelted particles. These attributes greatly affect the mechanical properties of a thermally sprayed coating. In general an inhomogeneous microstructure reduces the overall stiffness, coating strength, and integrity.

**Evaluation of coating quality at Thermaspray (Pty) Ltd**

Thermaspray prides itself in having the only metallurgical laboratory in Southern Africa dedicated to the evaluation of thermal sprayed coatings. Together with our partners Oerlikon Metco (formerly Sulzer Metco) and the TWI (The Welding Institute in the UK) Thermaspray have developed techniques specifically tailored to evaluate the quality of thermally sprayed coatings.

## Poor coating quality

Here are some examples of poor coating quality:

- Figure 1 shows a coating with lack of adhesion and cohesion. A coating of this quality will lead to flaking and peeling during in-service operations.

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*Figure 1: Example of a poor quality coating with flaking and a lack of adhesion*

- Figure 2 below shows a coating with foreign particles entrapped in the coating. This leads to poor cohesion and flaking and peeling during in-service operations.

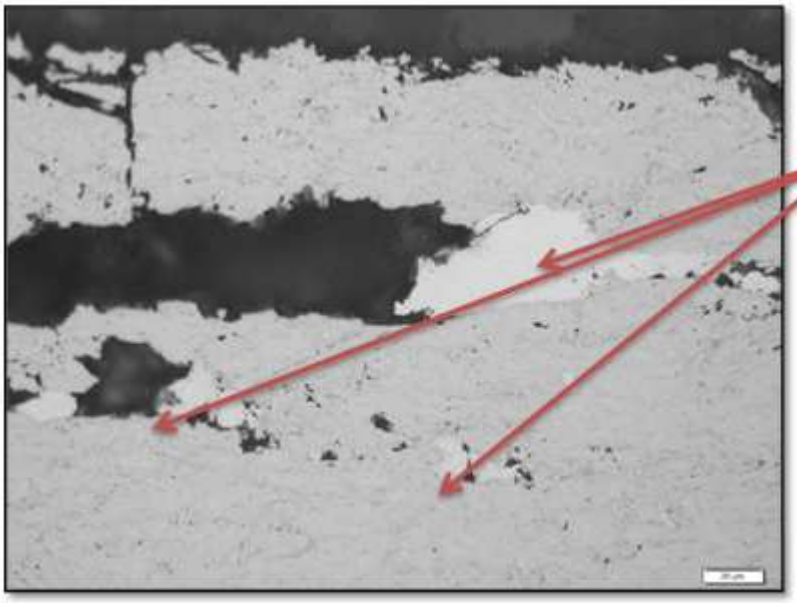


*Figure 2: Foreign particles in coating*

- Figure 3 shows excessive grit entrapment. Grit entrapment leads to poor adhesion to the substrate. It causes undue stress in the material leading to cracks in the coating. These cracks are weak points in the coating that will serve as points of attack in corrosive and abrasive environments.

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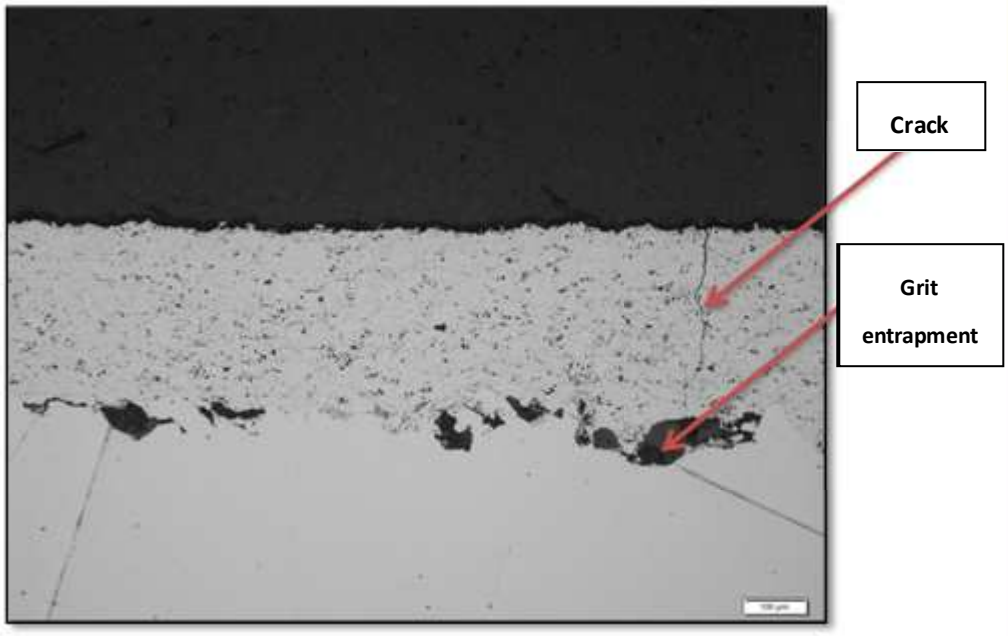


***Figure 3: Excessive grit entrapment and cracks***

- Figure 4 is another example of excessive grit entrapment and cracks in the coating.

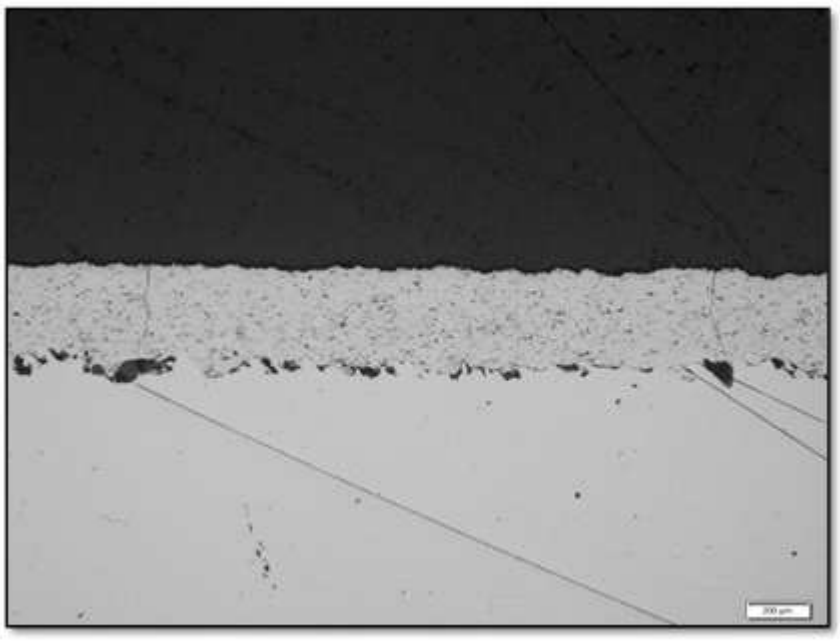

***Figure 4: Example of a poor coating with cracks and grit entrapment***

- Oxide inclusions appear as dark, elongated phases that appear as strings in the coating parallel to the substrate (Figure 5). These oxide inclusions lead to the added hardness of the coating.

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This increase in hardness leads to brittle coatings as oxides fracture easily. If these strings are too concentrated this will lead to a decrease in cohesive strength of the coating.

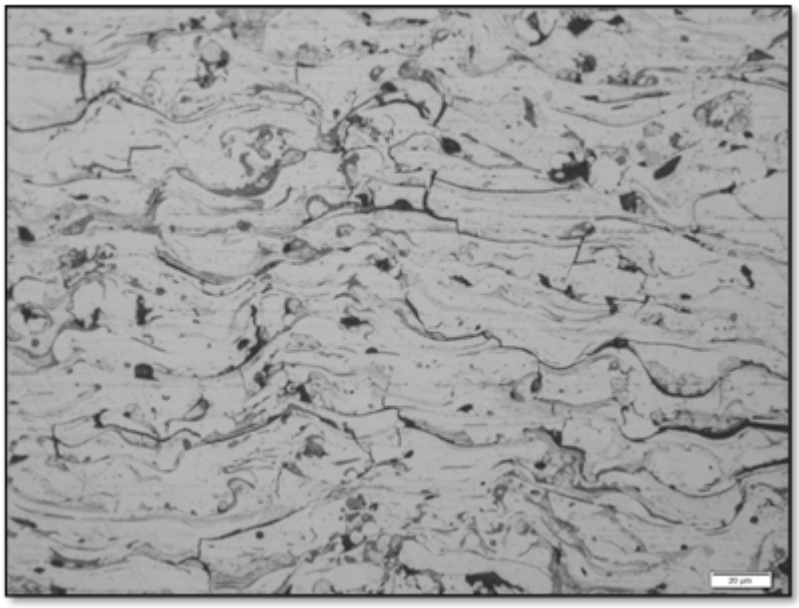

***Figure 5: Oxides in the coating***

- Porosity is another important factor that influences coating properties. Excessive porosity, as shown in figure 6, creates poor cohesion and allows for higher wear and corrosion rates. Poor cohesion can lead to cracking, delamination, and spalling.

***Figure 6: High porosity in thermal coating***

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- One of the most common causes of porosity is the presence of unmelted particles (figure 7). These solid particles, some of which are reflected from the coating surface, may adhere to or become trapped in, the rough finish of the coating. These particles are not well bonded nor are they in intimate contact with the underlying splat which creates voids and porosity.

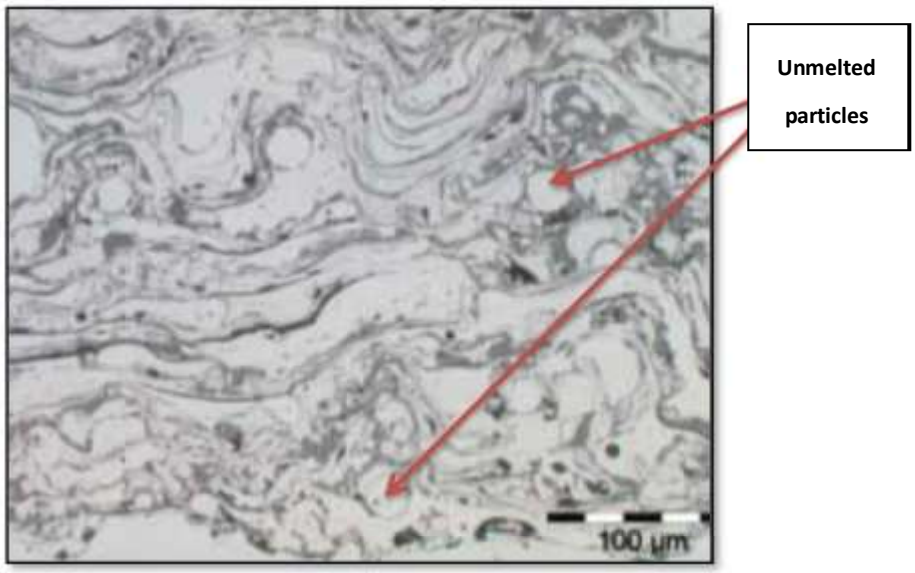


***Figure 7: Unmelted particles in coatings***

## Thermaspray coating quality

- With its dedicated metallurgical laboratory and staff, Thermaspray adheres to strict standards in its coating process and quality evaluation. Figure 8 shows a microstructure of a Thermaspray coating showing no crack, unmelted particles, oxides, and minimal porosity.

***Figure 8: Thermal spray coating micrograph with no defects and minimal porosity***

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- Figure 9 below shows a good coating quality with low porosity and the absence of flaws. It also shows no grit entrapment, ensuring maximum adhesion to the substrate.


***Figure 9: Coating micrograph with no grit entrapment and low porosity***

- Figure 10 again shows a coating with low porosity and the absence of flaws.

***Figure 10: Coating micrograph with low porosity and no defects***

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## Conclusion

Thermal spray coatings are used to address an ever-increasing variety of surfacing needs. Coating characteristics such as porosity, cohesion, and oxide content all play a role in the quality of a coating. Due to the criticality of industrial components, it becomes imperative that thermal spray coatings adhere to strict quality standards to ensure that the coatings do not delaminate, crack, or spall during operation saving on maintenance and unplanned downtime. Thermaspray remains at the forefront of the thermal spray coating industry in South Africa utilising its equipment and staff to ensure that its coatings are of the highest standards and quality.

## References


1. Thermaspray (Pty) Ltd internal documents
2. www.twi-global.com
3. www.gordonengland.co.uk



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