Evaluation of thermally sprayed coatings

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In the following results obtained by evaluation of the thermally sprayed coating samples sent by Praxair Surface Technologies and UniqueCoat Technologies.

The coatings obtained from UniqueCoat Technologies were:
- SB3072-1=1350VF -38+10 μm
- SB3072-2=1350VF -38+10 μm
- SB3073=1350VF -38+10 μm

The coatings obtained from Praxair were:
- Prax1=1350VM 090909J021
- Prax2=1350VM 090909J01
- Prax3=1275H 090911J01
- Prax4=1275H 090911J01-2

The coatings were evaluated using optical microscopy (Leica), microhardness tests (Matsuzawa MMT-X7+Buehler Omnimet MHT), SEM microscopy (Philips XL-30), tensile bond strength measurement and abrasion wear test (rubber-wheel abrasion test).

1. Results of UniqueCoat Technologies coatings

1.1 Optical micrographs

SB3072-1:
SB3072-1:

SB3072-2:
SB3072-2:

SB3073:
Summary of the optical micrographs: The microstructures of the SB-3072-1, SB-3072-2 and SB-3073 coatings are homogeneous and dense with very low porosity (less than 0.5%).

1.2 Microhardness values \( (HV_{0.3}) \) (10 measurements)

<table>
<thead>
<tr>
<th>Coating:</th>
<th>SB3072-1</th>
<th>SB3072-2</th>
<th>SB3073</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Hardness:</td>
<td>1440 HV</td>
<td>1449 HV</td>
<td>1449 HV</td>
</tr>
<tr>
<td>Min Hardness:</td>
<td>1265 HV</td>
<td>1209 HV</td>
<td>1203 HV</td>
</tr>
<tr>
<td>Mean Hardness:</td>
<td>1348 HV</td>
<td>1354 HV</td>
<td>1354 HV</td>
</tr>
<tr>
<td>Stdev Hardness:</td>
<td>65 HV</td>
<td>75 HV</td>
<td>76 HV</td>
</tr>
</tbody>
</table>
1.3 SEM micrographs
Summary of SEM micrographs: The SB-3072-1, SB-3072-2 and SB-3073 coatings showed homogeneous carbide distribution and augmented the dense structure with very low porosity (less than 0.5%) as seen also in optical micrographs.

1.4 Tensile bond strength

Tensile bond strength of the coatings was higher than 75 MPa, which was the bond strength of the glue used for testing adhesion.
1.5 Rubber-wheel abrasion test

Rubber-wheel abrasion test results are shown in the following chart. (Modified ASTM G65 test procedure, test duration one hour corresponding to a wear length of 5904 meters.). Wear resistance of the coatings is very high. Super-D-Gun SDG 2047 coating (WC-13%Co-4%Cr) tested years ago showed a weight loss of 57 mg in the same wear test.
2 Results of Praxair coatings

2.1 Optical micrographs

Prax1:
Prax2:
Prax3:
Summary of the optical micrographs:
The microstructures of the Prax1 and Prax2 coatings are homogeneous and rather dense with a low porosity (less than 1%).
The microstructures of the Prax3 and Prax4 (NiCrBSi) coatings have a porosity of the order of 5%.
2.2 Microhardness values \((HV_{0.3})\) (10 measurements)

<table>
<thead>
<tr>
<th>Coating:</th>
<th>Prax1</th>
<th>Prax2</th>
<th>Prax3</th>
<th>Prax4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Hardness:</td>
<td>1551 HV</td>
<td>1532 HV</td>
<td>831 HV</td>
<td>884 HV</td>
</tr>
<tr>
<td>Min Hardness:</td>
<td>1196 HV</td>
<td>1230 HV</td>
<td>616 HV</td>
<td>727 HV</td>
</tr>
<tr>
<td>Mean Hardness:</td>
<td>1371 HV</td>
<td>1395 HV</td>
<td>769 HV</td>
<td>803 HV</td>
</tr>
<tr>
<td>Stddev Hardness:</td>
<td>111 HV</td>
<td>78 HV</td>
<td>58 HV</td>
<td>57 HV</td>
</tr>
</tbody>
</table>

2.3 SEM micrographs
Summary of SEM micrographs: The Prax1 and Prax2 coatings showed homogeneous carbide distribution and augmented the dense structure with low porosity (less than 1\%) as seen also in optical micrographs. The Prax3 and Prax4 coatings showed typical structure of HVOF sprayed NiCrBSi coating with a porosity of the order of 5\%.

2.4 Tensile bond strength

Tensile bond strength of the coatings was higher than 75 MPa, which was the bond strength of glue used for testing adhesion.

2.5 Rubber-wheel abrasion test

Could not be carried out due to too small samples.

3 Summary

The WC-Co-Cr coatings obtained from UniqueCoat Technologies and Praxair Surface Technologies were manufactured from the 1350 VM powder. The coatings were about similar in hardness; of the order of 1350 HV$_{0.3}$. The porosity of the coatings manufactured by UniqueCoat Technologies was lower than that of coatings deposited by Praxair Surface Technologies as can be seen from optical and SEM micrographs. Abrasion wear resistance was evaluated only with the coatings delivered by UniqueCoat Technologies and they showed very high wear resistance in the rubber-wheel abrasion test.
The 1275H (NiCrBSi) coatings were obtained only from Praxair Surface Technologies. They had hardness of about 800 HV$_{0.3}$ and higher porosity as compared to WC-Co-Cr coatings.

Tensile bond strength of all the tested coatings was higher than 75 MPa, which was the bond strength of the glue used for testing adhesion.