Surface Modification Techniques

THERMAL SPRAY COATING IN AEROSPACE

GROUP 12

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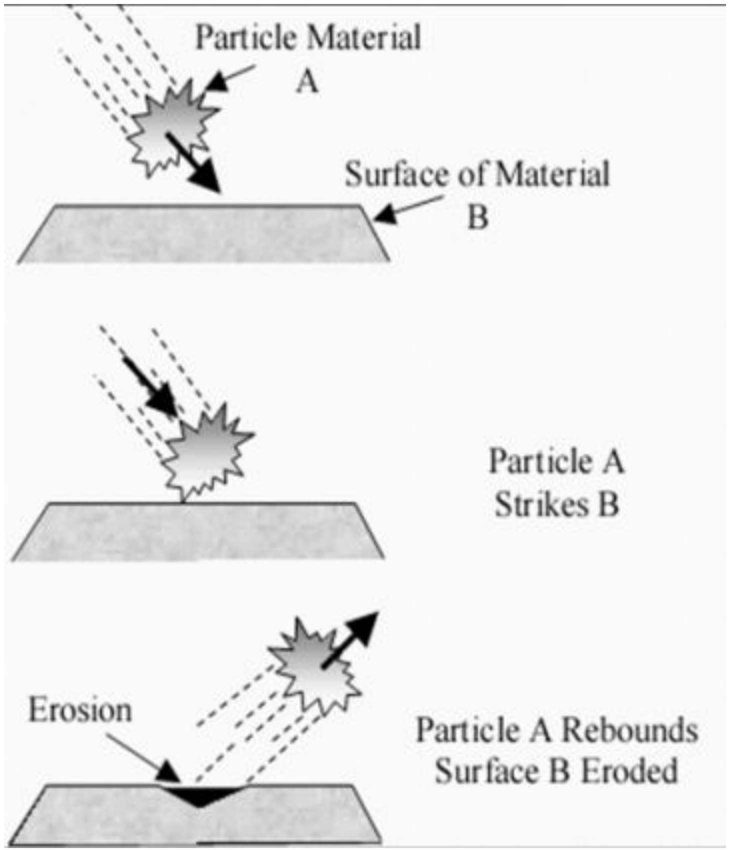
WEAR/CORROSION

- Wear is a process of removal of material from , occurring when two solid surfaces are in sliding or rolling motion together.

- Solid particle erosion is a result of the impact of a solid particle A, with the solid surface B, resulting in part of the surface B been removed, which is known as erosion of materials or components.



COATING METHODS

The types of surface coating methods are :

1)Thermal Spraying (Metal Spraying)

2) Chemical Vapor Deposition (CVD)

3)Physical Vapor Deposition (PVD)

Thermal spray coating

- Thermal or Metal spraying is a group of processes wherein a feedstock material is heated and propelled as individual particles or droplets onto a surface.
- Sprayed particles impinge upon the surface, they cool and build up, into a laminar structure forming the thermal spray coating.

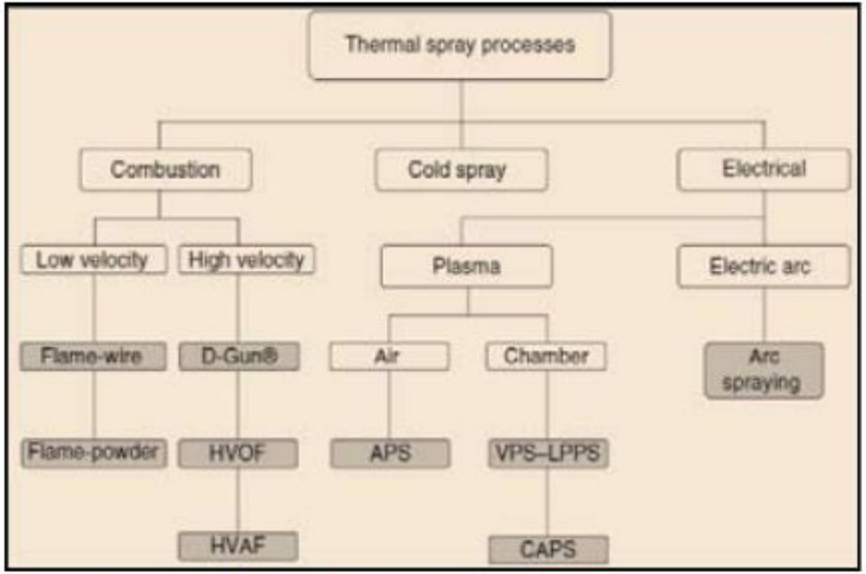


Fig. 4: Types of Thermal Spray Processes

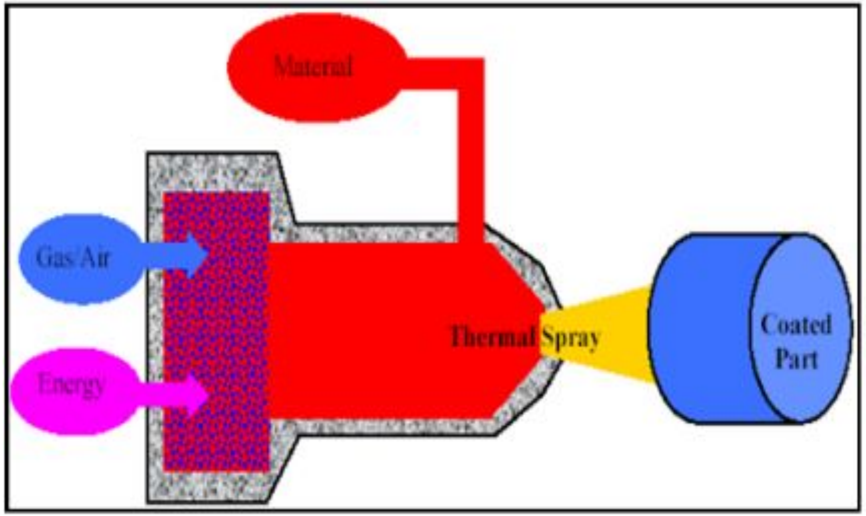


Fig. 3: Schematic of Thermal Spray

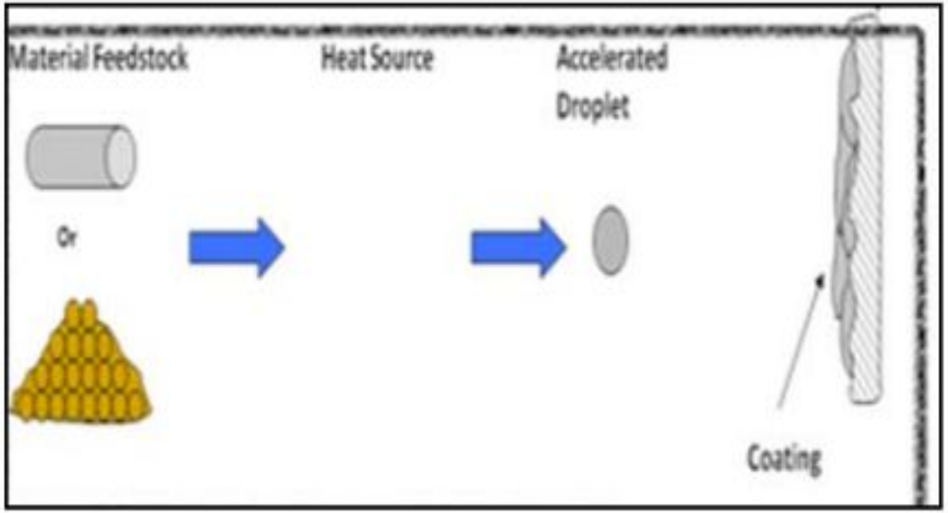


Fig. 2: Thermal Spray Process

Applications in aerospace

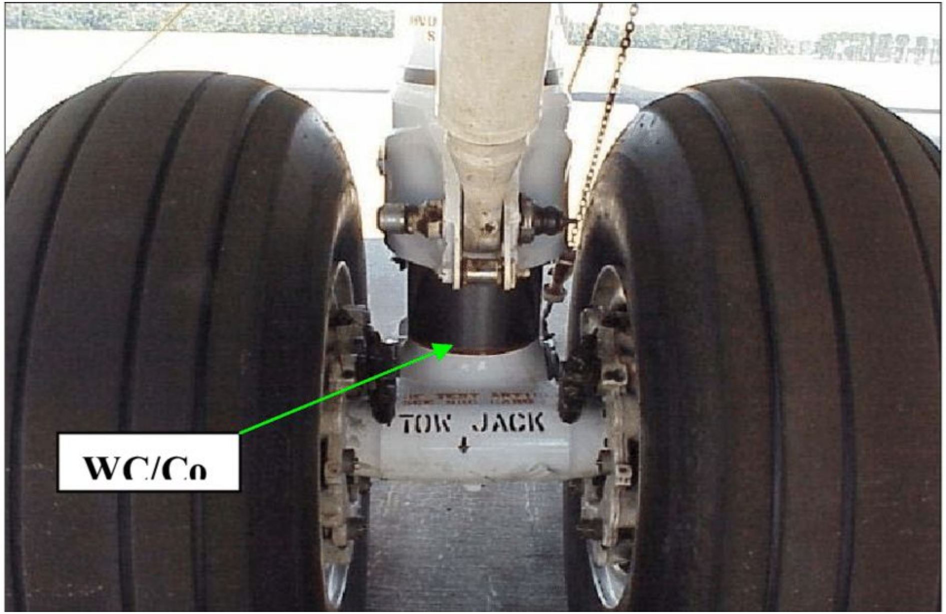
Parameters of aerospace systems

1. friction
2. wear in various devices
3. humidity variations
4. altitude changes
5. broad temperature ranges.

Plasma sprayed deposition of abrasive and abradable coatings are commonly used in aerospace applications.

Preparation of WC-Co(Tungsten carbide cobalt) powder

1. Mixing tungsten carbide, water-soluble cobalt salt, carbon source and water to obtain a mixed slurry.
2. The mixed slurry is ball milled and then spray granulated to obtain a cobalt salt coated WC precursor powder;
3. The cobalt salt is coated with a WC precursor powder to carry out reduction carbonization to obtain a WC-Co powder.



EXPERIMENTAL (PLASMA SPRAY COATING)

1. WC-Co powder with particle grain sizes of 45-100 µm was deposited on the surface of structural steel CK60 specimens having a composition of 0.60% wt C, 0.40% wt Si, 0.75% wt Mn, 0.035% wt P and 0.035% wt S.
2. Tensile and corrosion specimens had dimensions 130 x 90 x 2.1 mm3 , while flat circular test pieces, approximately 38 mm in diameter and 10 mm thick, were cut-off for wear tests.
3. All specimens were grit blasted using coarse alumina. Ultrasonic cleaning in alcohol followed by hot air drying served to remove oil and grit residues. Spraying was performed within a period of 10 min following sandblasting.

Plasma spray coating (Tungsten carbide cobalt)

WC-Co coating is deposited on both sides of the flat specimens in equal thicknesses as indicated in table 2 in order to enable balanced loading during the tensile test. Circular test pieces were sprayed to an average coating thickness of 450 µm.

Table 2. Coating thickness

sample	Thickness per side (µm)
A	72
B	432
C	203
D	356
E	152

The as received WC–Co powder consists of WC and Co phases and also contained some amount of W3Co3C.

The sprayed WC–Co coating includes W2C peaks, indicating that the WC has been decarburised into W2C under the present APS conditions.

No Co or free C phases were indicated in the XRD spectrum of the coating, probably implying that their presence was in amorphous state.

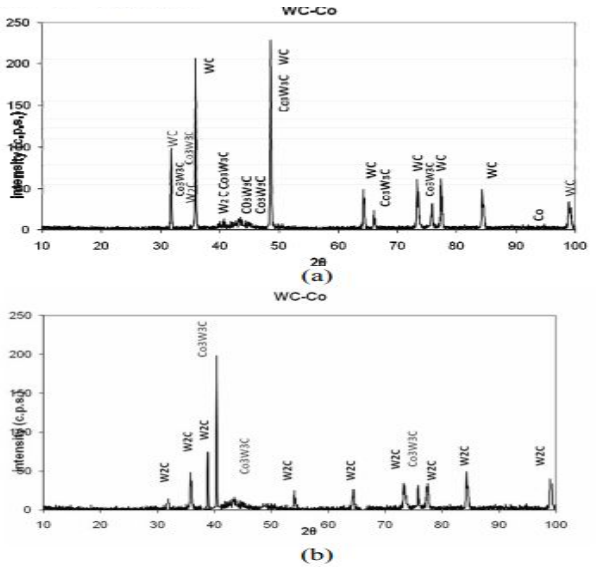


Figure 3. XRD patterns of WC-Co powder prior (a) and after (b) plasma spraying

RESULTS AND DISCUSSION

1. Figure 4 shows the corrosion potential of the coated and uncoated specimens as a function of immersion time.
2. It can be seen that voltage is moving towards more negative values indicating corrosion of the system.
3. The corrosion rate of the coated steel is lower indicating protection of the WC-Co to the steel substrate. Steel behaviour in chlorine rich environments can be described as follows.

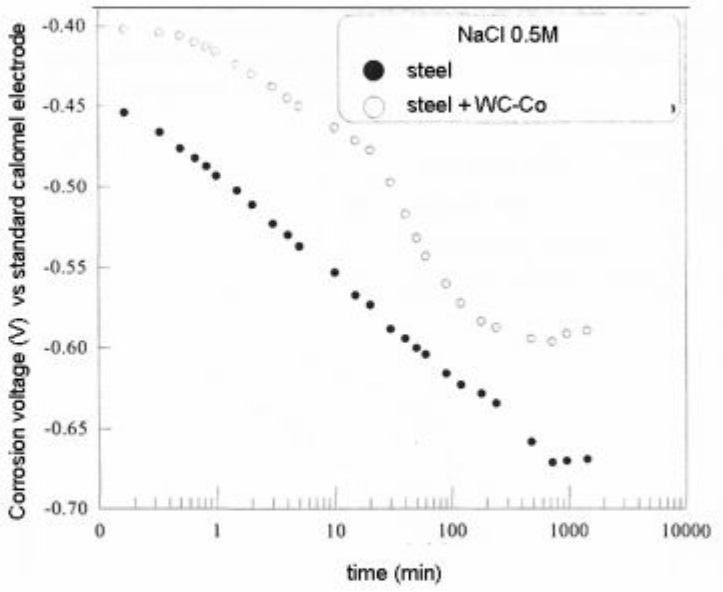


Figure 4. Corrosion voltage as a function of time for coated with WC-Co and uncoated steel

1. Figure 5 shows the engineering stress – strain curves for the WC-Co coated steel substrate with various coating thickness.

2. During tensile testing the coating started cracking at the end of elastic strains just after the yield point. The experimental results show that the WC-Co plasma spray coating weakens the steel substrate in the elastic region.

3. It can be noted that the elastic modulus of the coated system decreases drastically with respect to the theoretical calculations as coating thickness increases.

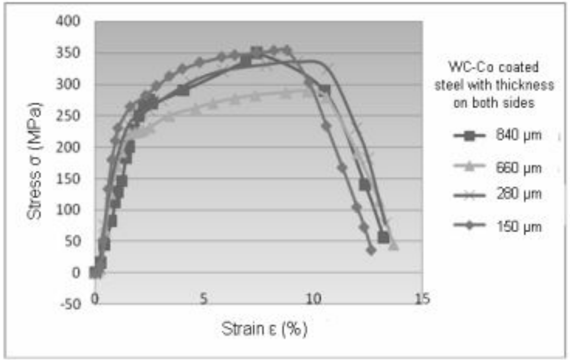


Figure 5. Stress – strain curves of WC-Co coated steel with various thicknesses

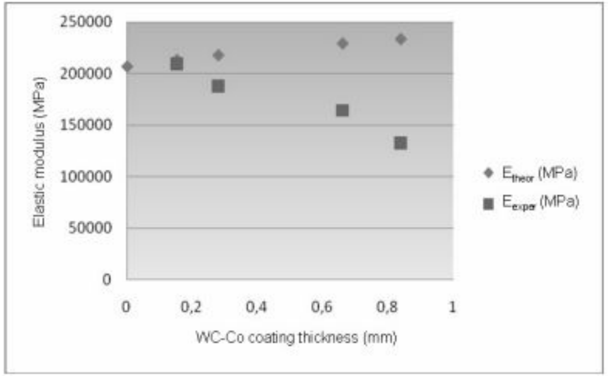


Figure 6. Elastic modulus of the WC-Co coated steel as a function of the coating thickness

THANK YOU