TCR Advanced Engineering P. Ltd

Experts in Metallography, Failure Investigation and RLA

Metallurgy for Industries

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Characterization of Thermal Barrier Coatings (TBC)

A unique approach by metallography.

Why TBC is required?

Thermal Barrier Coatings protect turbine components against wear, corrosion and friction. Two basic criteria should be borne in mind for the selection of coatings:

- To protect the component from degradation.
- To retain its protective properties in the aggressive environment over long run.

Efficiency in the turbines is primarily governed by increase in the incoming gas temperature to the engine turbine. Besides the high temperature and the associated changes resulting increase in temperature gradient, the engine operates under high pressure and huge stresses in the presence of corrosive and oxidation atmosphere. During operation, engine components undergo degradation.

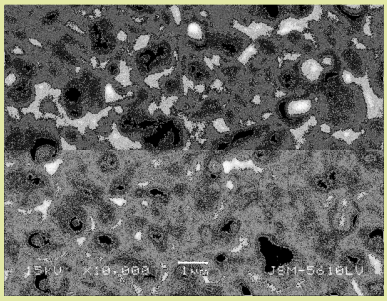
Evaluation of the coated samples:

1. Microstructure examination is done using specialized technique as per ASTM E1920.

Microstructure preparation is a very important step in evaluating TBC samples. Care needs to be taken from cutting up to the final polishing stage. Many a times, if it is not done with meticulous procedure, the layer of TBC may get broken or distorted, resulting in false interpretation. Micro preparation for TBC samples involves hi-tech/advanced micro preparation tools like diamond cutting to auto polishing machines. Sample preparation being very critical, metallography is also termed as an art. The interpretation of the TBC requires a high level of experience and metallurgical knowledge. Hence, it is both art and science.

Sample microstructure prepared at TCR advanced is shown as under, where in clear top coat, bond coat interface boundary between coats and base metal can be clearly identified.

Microstructure of the Month



Magnification: *10000X*

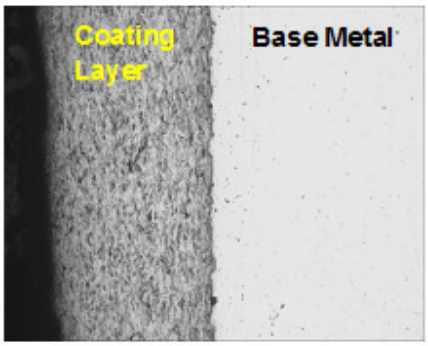
Component: *Vacuum Hardening & Sub-Zero Heat-Treatment Sample*

MOC: *Martensitic stainless steel (X46Cr13)*

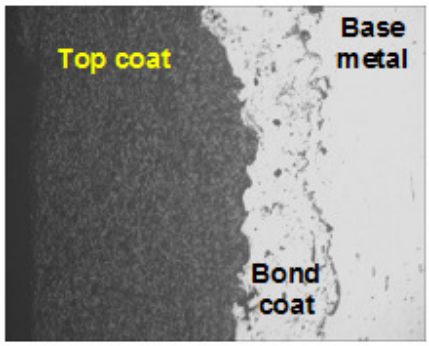
Etchant: *Villella's Reagent*

Observation: Image shows fine tempered martensite structure with rounded alloy carbides at the facets of martensite regions. Fine precipitations of eta carbides are observed evenly distributed in the microstructure.

Useful Hint: Presence of eta carbides would improve the wear resistance and stability of the microstructure.



Coating: Tungsten carbide (100X)



Bond coat: Amdry 962; **Top layer:** Amdry 6420 (100X)

2. Porosity level measurement

If the sample is not prepared properly, the porosities may get distorted/deformed. This may lead to incorrect volume fraction of porosity. Hence, the sample should be prepared with a lot of care.

Measurement needs to be done using precision measuring tool, automated image analyzer software.

Tungsten carbide coating:

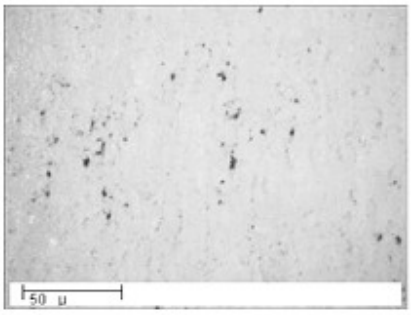


Plate: 1 As polished (400X)

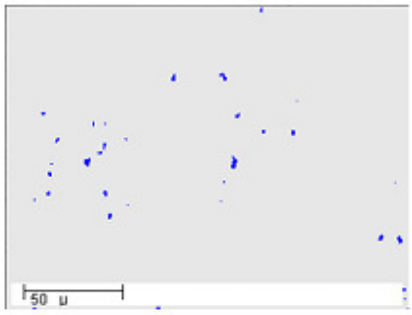


Plate: 2 Solarized image (400X)

3. Micro-hardness measurement

Sample preparation is of paramount importance in micro-hardness measurement. Care should be taken that both the faces of the sample are perfectly flat. Un-parallel face may lead to incorrect measurement of indentation and hence micro-hardness.

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