Standardization in Quality Control of Thermal Spray Coatings (part 2)

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In Essen at the ITSC2002, the initial results of the EACMT (European Airline Committee for Materials & Technology) Sub-Committee on Standardization in Quality Control of Thermal Spray Coatings for the Aircraft Industry were presented [1]. The ITSC Orlando 2003 presentation will quickly summarize this past work and then present the latest progress on standardization concerning frequency of testing (for quality control) and metallographic evaluation to common photo standards. Focus will be on the definitions photographs and typical rating photos of specific coatings.

The ultimate goal is to have this standardized work incorporated into the Standard Practice Manuals of all aircraft engine OEM's around the world. With the many Original Equipment Manufacturer's (OEM's) criteria for evaluation of thermal spray materials, laboratories are forced to have multiple criteria/systems to test and analyze coatings. As airlines/repair shops are moving towards overhaul of more variable engine types/models in their shops, the need to have a common evaluation system has been identified and is currently being addressed. A sub-committee of the European Airline Committee for Materials Technology is currently working to formulate this common system for thermal spray coatings evaluation. Participants are from GEAE, Pratt & Whitney, Rolls Royce, SNECMA and KLM Royal Dutch Airlines [2]. The progress and goals of this group will be documented and reported.

1 Introduction

Within the aircraft business there are three markets where money is currently being made: transportation of people, transportation of cargo and aircraft overhaul & repair. In the aircraft overhaul & repair industry repairing multiple engine types is a major issue for airlines, independent repair shops and OEM's. Standardization of testing and manufacturing processes is a very important goal. This will save time and money. Since April 1997, a subcommittee of the European Airline Committee for Materials & Technology (EACMT) has been working on the standardization of the quality control for thermal spray coatings.

1.1 Standard Practices Manuals

The current state of testing in the aerospace overhaul & repair industry is a variety of Standard Practice Manuals (SPM's) from the major OEM's with many different requirements. Each major manufacturer uses different tests, rating systems, definitions of characteristics, and acceptance criteria.This means a repair shop has to expend more effort, time and money to fulfill all the different requirements. The end result is the inability of a repair shop to develop a universal system for thermal spray coating evaluation.

As more shops repair multiple engine types across many OEM lines, the necessity for a more universal system is obvious.

1.2 The EACMT

The driving force for the formation of the EACMT was the desire for varied AEA (Association of European Airlines) members to meet together and discuss issues associated with repair of aircraft components. The first working group meeting was held in 1967 in Hamburg. In due time, the OEM's were invited to participate in the working group. The main emphasis of the committee is on surface treatments, special processes and health & safety. Often sub-committees of the EACMT are established to deal with a detailed subjects. Members of such a sub-committee are mostly specialists from both the Airlines and the OEM's. The sub-committee on Standardization of the Quality Control for Thermal Spray Coatings was established in April 1997. Present members of this sub-committee are from KLM Royal Dutch Airlines, GEAE, Pratt & Whitney, Rolls-Royce and SNECMA.

2.0 Major goals & achievements

The major goals are standardization & harmonization (S&H) of the quality control system which will

eventually result in saving time and money. Five major areas of testing have been reviewed:

1. Necessity of each individual tests
2. S&H Tensile bond strength testing
3. S&H Hardness testing
4. S&H Frequency of testing
5. S&H Metallographic Investigation

Reviewing each individual tests (1) resulted in deleting the following superfluous tests:

- Cup test
- Stamp test
- Scratch Hardness test
- Bend test
- Lap shear test

Reviewing the tensile bond strength test (2) resulted in standardization and harmonization on among other things of the following items:

- grips
- substrate materials
- substrate preparation
- coating thicknesses
- adhesives
- bonding test bars
- test evaluation and disposition criteria

Reviewing the hardness test (micro/macro) (3) resulted in standardization and harmonization on among other things of the following items:

- coating thickness
- number of indentations

Reviewing the frequency of testing (4) resulted in standardization and harmonization on among other things of the following items:

- initial qualification
- requalification
- on-going qualification

Reviewing the metallographic investigations (5) resulted in standardization and harmonization on among other things of the following items:

- metallographic equipment & preparation
- metallographic definitions and rules
- metallographic generic photos
- metallographic specific photos
- metallographic “accept/reject“-rating system

In focusing on the task of identifying attainable goals for the committee, the initial target of the group was to identify and develop metallographic methods / requirements for three common coatings (NiAl, WC/Co, CrC/NiCr). However soon it was realized the problem was a lack of system not just quick photos for three coatings. So, since the last ITSC the main emphasis of the sub-committee efforts were on the generic & specific photos and the accept/reject-rating system.

2.1 Example photos

From all metallographic definitions and rules coating example has been chosen for generic photos.

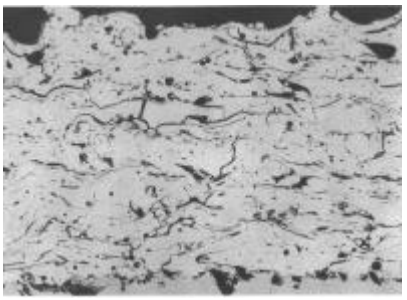


Figure 1 Photo of cracks

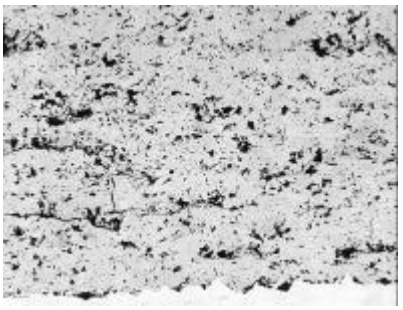


Figure 2 Photo of delaminations

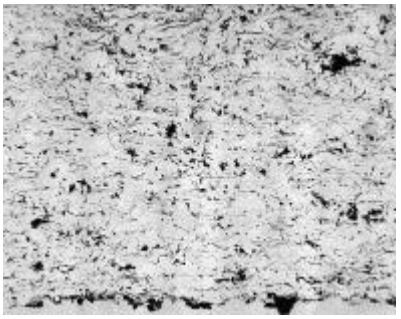


Figure 3 Photo of interface contamination

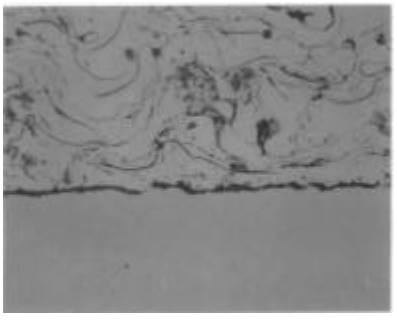


Figure 4 Photo of interface seperation

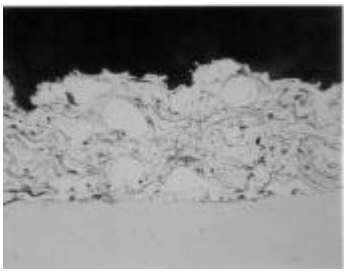


Figure 5 Photo of unmelted particles

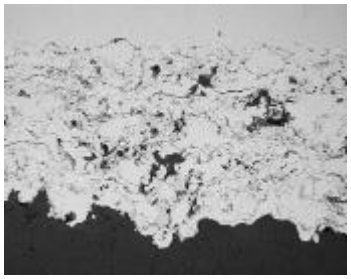
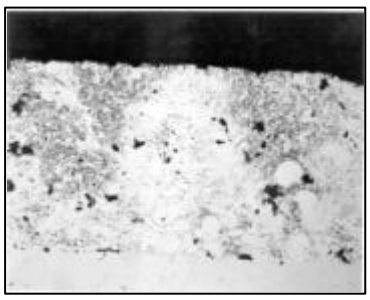


Figure 6 Photo of massive porosity



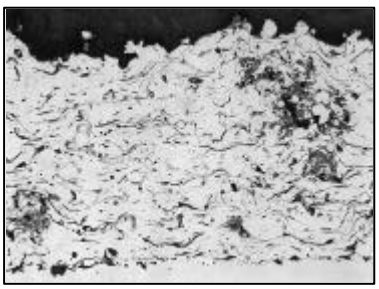


Figure 7 Photos of oxide clusters

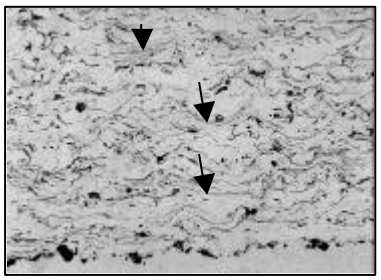


Figure 8 Photo of oxide stringers

2.2 Specific photos

From all metallographic definitions and rules only oxides and porosity were considered to be coating specific. The specific example photo's still have to be chosen by the committee.

As mentioned earlier the first coating specific photos for a future harmonized metallographic atlas comprices of a Nickel/Aluminium 95/5 coating, a Tungstencarbide / Cobalt 88/12 coating and a Chromecarbide / Nickel-Chrome 75/25 coating.

Future work of the OEM's will expand the number of photo's of other coatings

2.3 "Accept/reject"-rating system

Among other things the following accept/reject rating items for thermal spray coatings was agreed on:
- No cracks allowed
- No delaminations allowed
- No seperation allowed

Discussions are still going on for the following rating items:
- Massive porosity (by numbers or percentage)
- Interface contamination (by a percentage)
- Oxides (by comparison)
- Oxide clusters (by numbers)
- Porosity rated (by a percentage)
- Unmelted particles (by numbers)

3.0 Conclusions

The need for standardization and harmonization of the quality control for thermal spray coatings in the aerospace industry has been identified and the EACMT sub-committee is addressing all aspects of this issue. Thanks to the close cooperation of the major engine OEM's, the goals of the sub-committee almost have been achieved. The upcoming complete revisions of all Standard Practices Manuals of the OEM's will be the result of this succesfull workman-ship.

3.1 Future

The ultimate goal is to address all different thermal spray coatings in the SPM's in the same way and in the same template as the small representative segment was chosen as a starting point.

References:

[1]
Standardization in coating evaluation: An universal system for repair coatings.
[2]
GEAE/Belcan – Mr. T. Kessler
GEAE – Mr. S. Tefft
Sauer Engineering – Mr. J. P. Sauer
P&W – Mr. D. Rutz
P&W – Mr. M. Freling
P&W – Mr. J. Sabine
P&W – Mr. N. Ridgeway
P&W – Mr. S. Narsavage
P&W – Mr. T. Tabor
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RR – Mr. R. Smyth
RR – Mr. D. Gill
RR – Mrs. S. Azmy
KLM – Mr. M.S.E.G. van Wonderen