oerlikon
metco

Solutions Flash

Outstanding thermal protection for turbine engines with high performance XCL thermal barrier materials

SF-0004.5 – October 2014

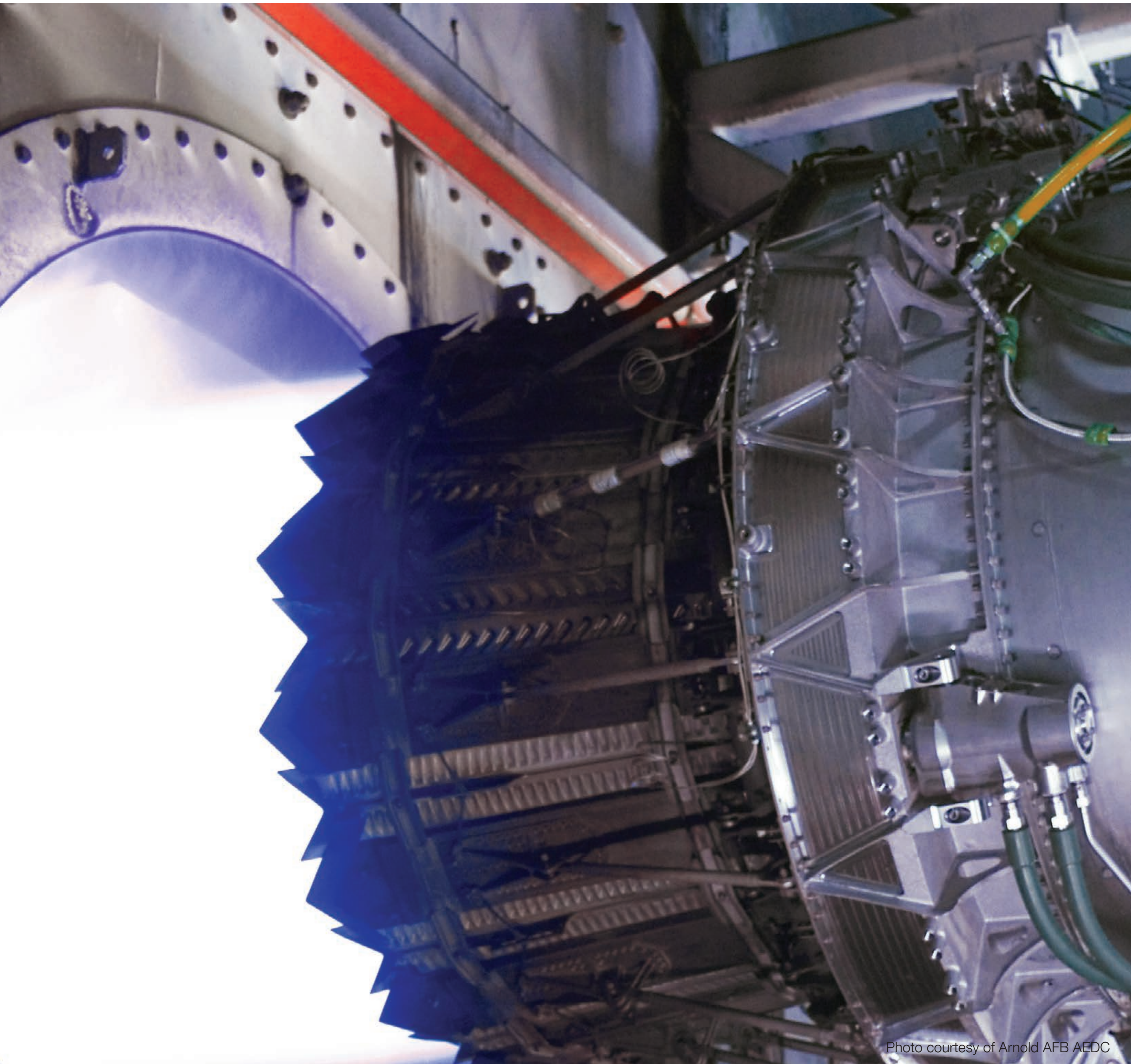


Photo courtesy of Arnold AFB AEDC

Today's situation

All manufacturers of turbine engines are investing considerable development effort into the combustion section of the engine compelled by:

- The rising cost of fuel resulting in the demand for greater operating efficiency
- Even more stringent environmental regulations for cleaner exhaust emissions
- Operator demand for longer hot section service life
- The need for reliable, yet economical, manufacturing and overhaul processes

Higher combustion temperatures result in a more complete burn. This results in greater thermal and fuel efficiency, as well as environmentally cleaner emissions. However, without better thermal protection for hot section components, these higher temperatures will reduce component service life. This growing demand for higher efficiency and longer component life is driving the development of thermal barrier coatings (TBCs) that will meet these performance requirements that cannot be met using conventional TBC materials.

The Oerlikon Metco solution

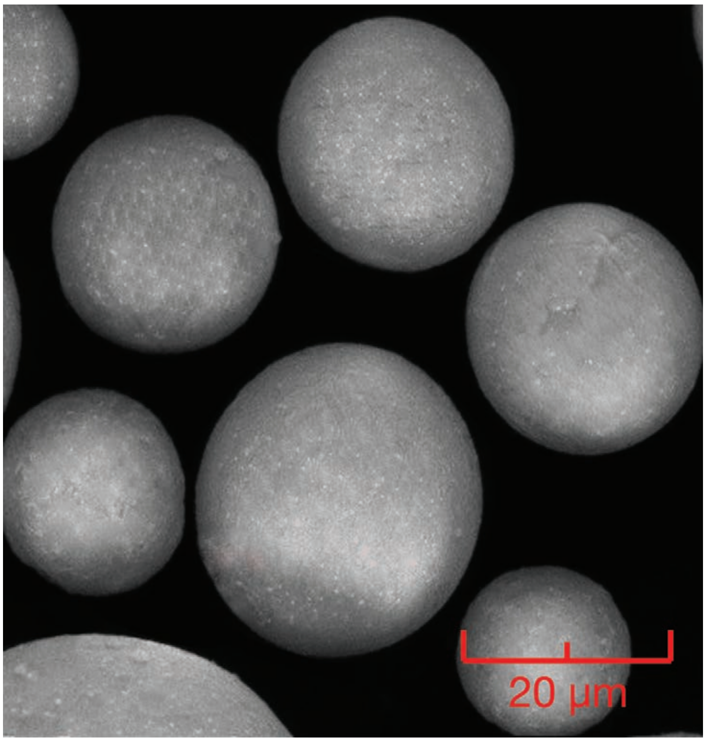
Oerlikon Metco's new XCL TBC materials deliver outstanding performance in turbine engines with service temperatures that are 150 to 200 °C (270 to 360 °F) higher than conventional TBC materials. Coatings produced from XCL materials run longer and hotter, without spallation, meeting extended time between overhaul (TBO) requirements and higher service temperature requirements.

XCL materials are manufactured using HOSP™ technology, pioneered by Oerlikon Metco and well known throughout the world for TBC materials with excellent flowability, sprayability and quality for thermal protection. XCL materials are high purity, minimizing shrinkage in service, even for turbines operating at increased temperatures.

Furthermore, XCL materials contain lower levels of uranium and thorium impurities than conventional TBC materials.

At the same time, the new XCL materials can be applied using conventional spray parameters, and most facilities will be able to switch to the new materials without the need to develop new parameters. Finally, the XCL products are cost-competitive compared to conventional TBC materials.

In summary, Oerlikon Metco's XCL TBC coating materials bring excellent value, with no downside risk or compromise.



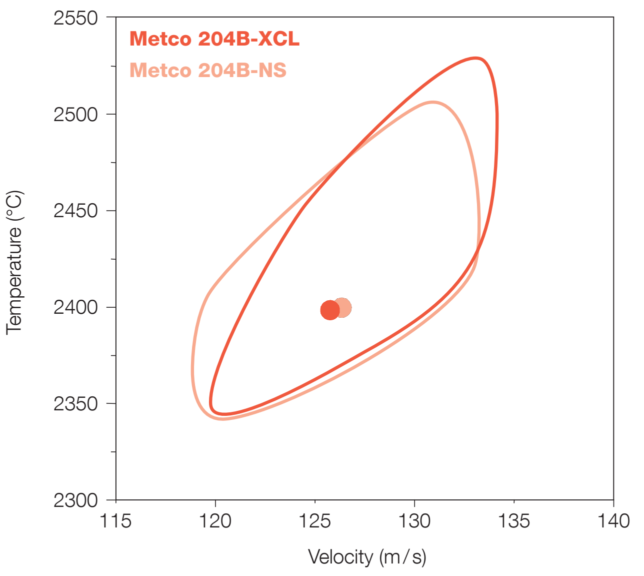
SEM photomicrograph of Metco 204-XCL powder particles manufactured using the Oerlikon Metco HOSP process.

Solution description and validation

Testing of our XCL TBC materials by aerospace OEM's, IGT OEM's and universities has revealed key economic, technical and environmental advantages compared to conventional TBC materials that allow our customers to meet ever growing demands through greater product reliability.

Processing

Many operators will find that their spray parameters will require little or no adjustment when switching to XCL materials from another material, particularly another HOSP product. Coatings produced using XCL materials are very white, demonstrating the purity of the product. Furthermore, XCL products are cost competitive compared with other TBC materials.



In-flight particle temperature and velocity profile of Metco 204B-XCL and Metco 204B-NS as measured using Accuraspray-g3

Coating Appearance

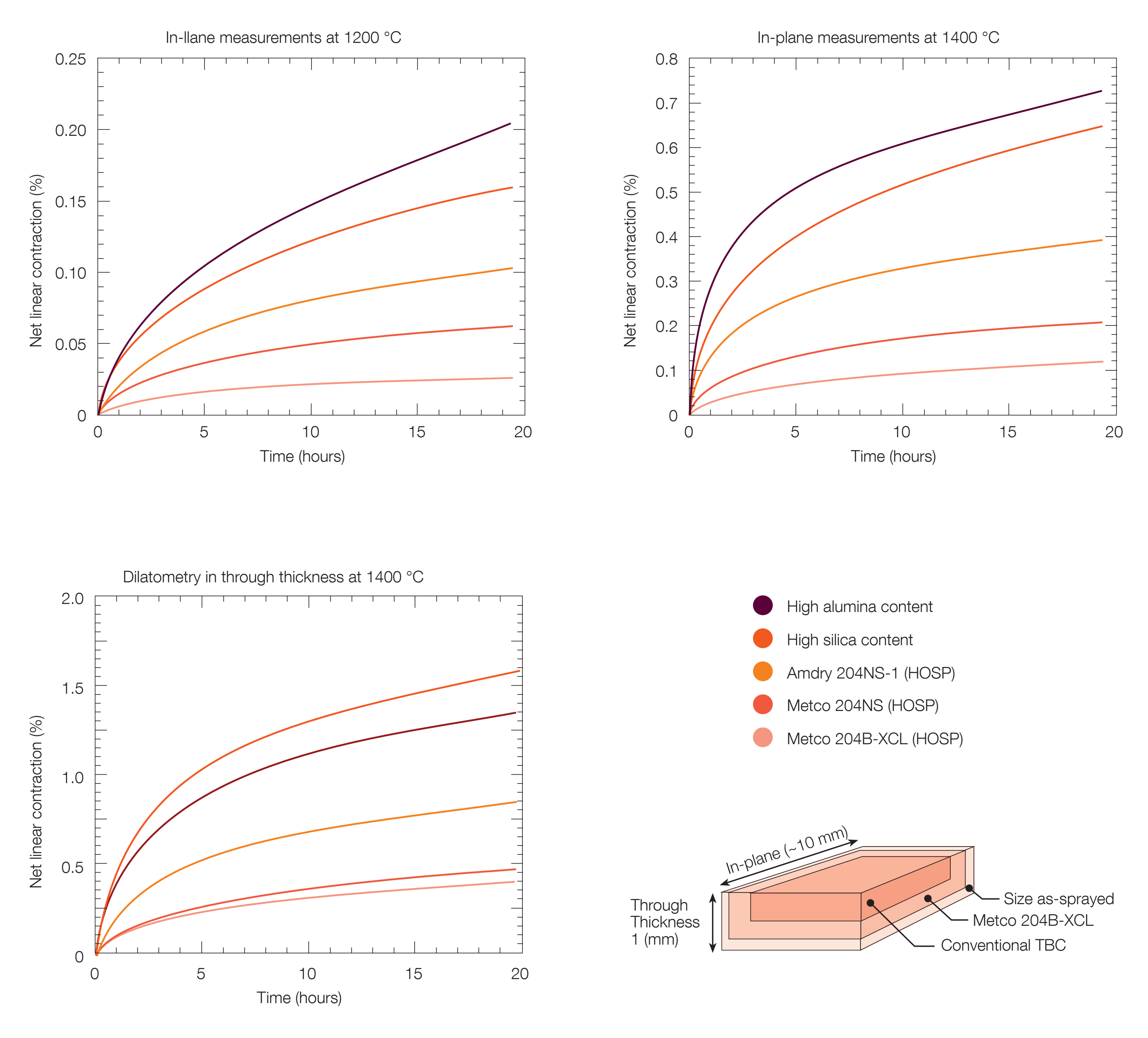
The quality of Oerlikon Metco's HOSP YsZ materials has long been recognized by the white color of the coatings they produce. Yet, our XCL materials produces coatings that are even whiter than coatings of existing materials. This is a direct result of the high purity of the new material.

Metco 204B-NS Coating (standard material)

Metco 204B-XCL Coating (new material)

Sintering resistance

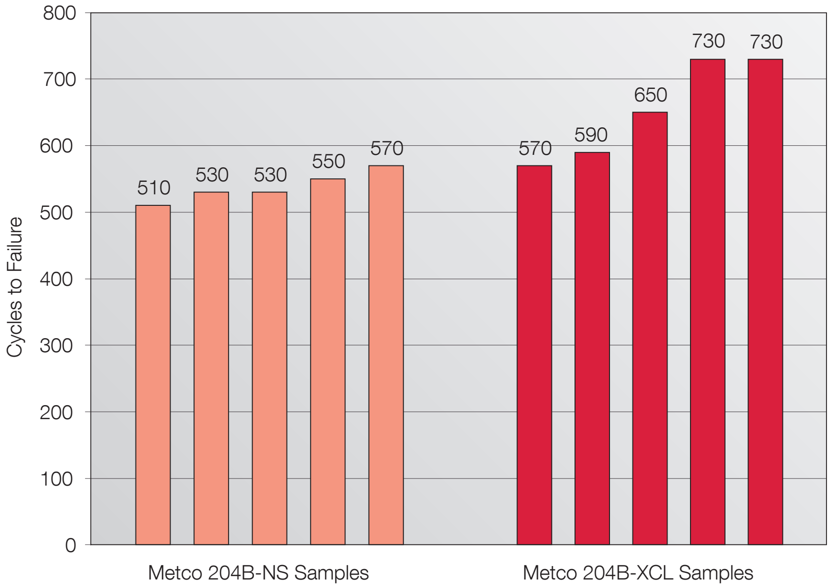
Independent laboratory tests indicate that XCL coatings demonstrate superior sintering resistance in service, resulting in lower shrinkage compared to other TBC materials, including Oerlikon Metco's own Metco 204NS, considered by many to be the industry standard for high purity YsZ material prior to XCL. Not only do the XCL materials outperform other YsZ materials at the current upper operational temperature range 1200 °C (2200 °F),testing has demonstrated that coatings of XCL materials have outstanding performance at temperatures up to 1400 °C (2550 °F). This higher temperature range means that coatings of XCL materials have a comfortable margin for today's engine requirements.

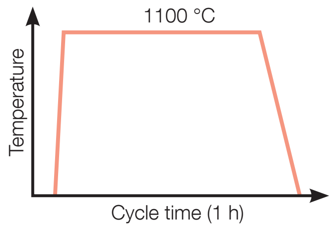


Thermal cycling life test

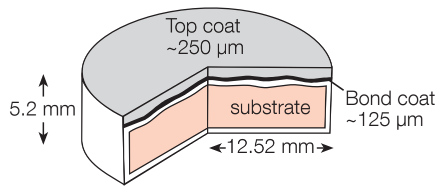
Thermal cycling life testing was performed on coated buttons of Metco 204NS and Metco 204B-XCL. Samples were rapidly brought up to a temperature of 1100 °C, held at temperature for one hour and rapidly cooled to ambient. This cycle was repeated until the coating delaminated.

- Substrate: Hastalloy X
- Bond coat: Air plasma sprayed Amdry 995C
- Top coat: Metco 204B-NS or Metco 204B-XCL





A single thermal cycle, repeated until the coating delaminated.



Button samples

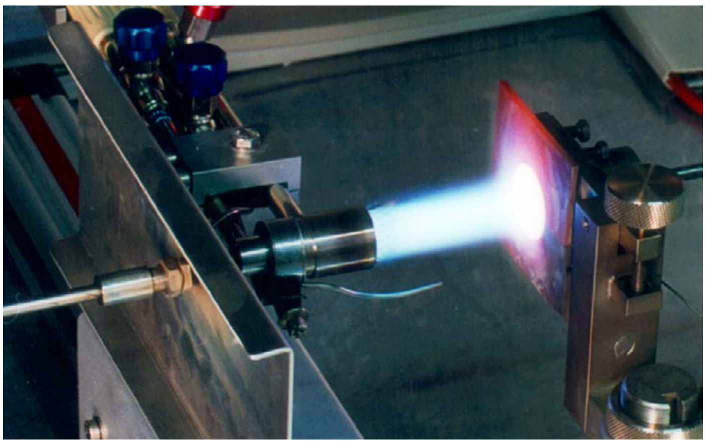
XCL thermal barrier coatings significantly outperformed conventional YsZ materials in thermal cycling life testing, with the worst XCL coating sample being equal to the best conventional YsZ sample.

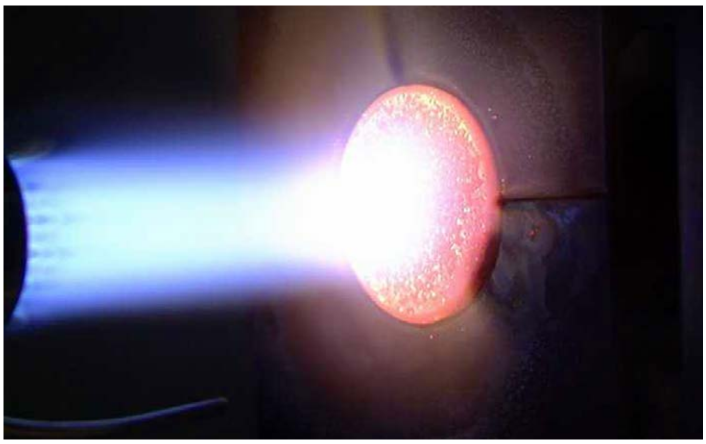
Gradient thermal shock testing

Coated samples of Metco 204B-NS and Metco 204B-XCL were subjected to an aggressive gradient thermal shock testing for 2000 cycles without failure, at which time, testing was stopped.

Test details

- Surface temperature: 1238 to 1250 °C
- Substrate temperature: 1020 to 1031 °C
- Cycle: 5 minutes heating and 2 minutes cooling.
- During heating, the burner heats the coating surface while the back of the substrate is cooled with compressed air.

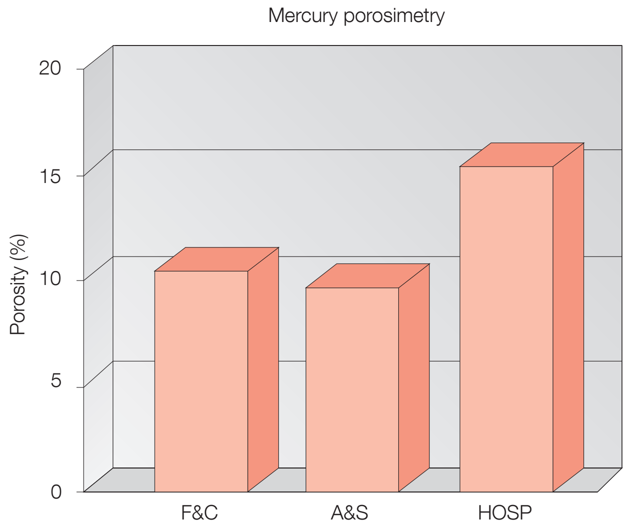


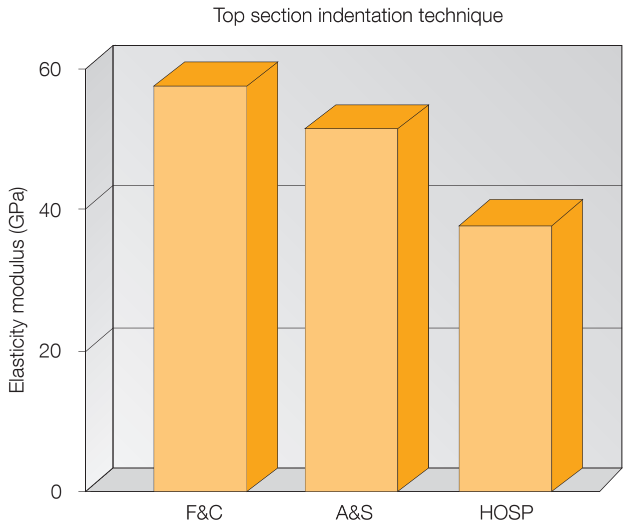


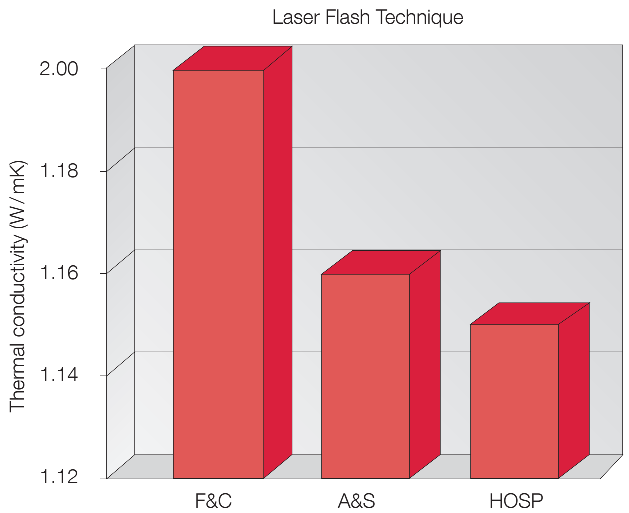
Images courtesy of FZ Juelich GmbH, Institute IEF

Manufacturing method vs. coating performance

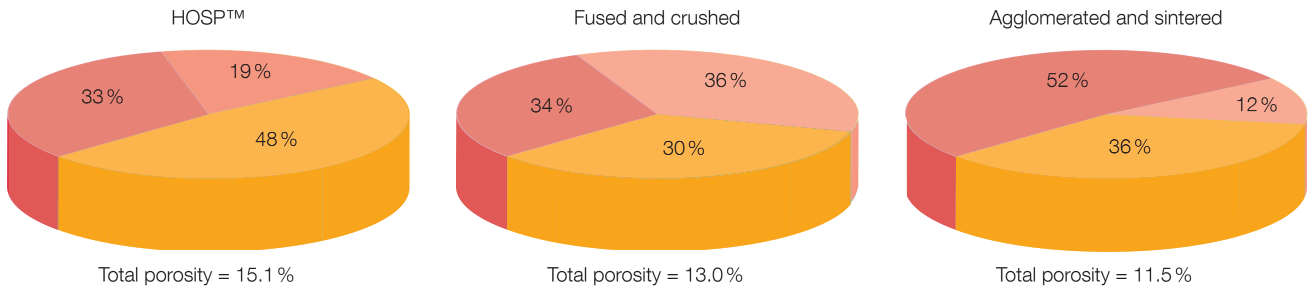
The powder manufacturing method for TBC materials plays a role in the performance of the coating. The Oerlikon Metco HOSP manufacturing technique clearly demonstrates better compliance, high coating porosity and lower thermal conductivity than TBC coatings of any fused and crushed (F&C) powder or standard purity agglomerated and sintered (A&S) powders.



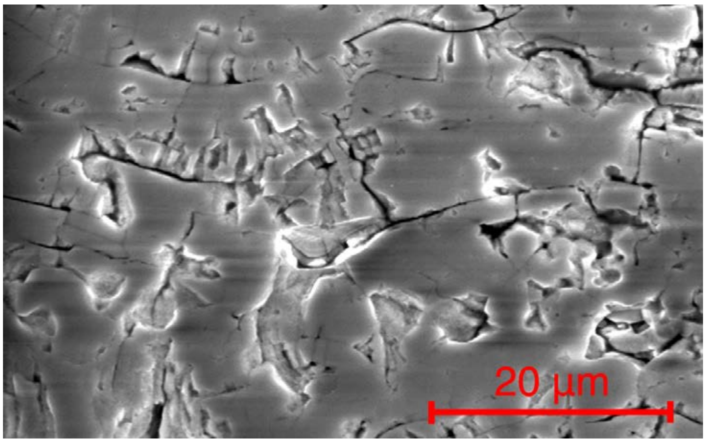




Evidence indicates that thermal barrier coatings produced from HOSP materials have greater total porosity values than either fused and crushed or agglomerated and sintered materials when globular porosity, interlamellar porosity and intrasplat cracks are considered. Furthermore, the greatest percentage of total porosity in HOSP coatings is interlamellar, which is thought to enhance the thermal barrier effect and provide compliance.



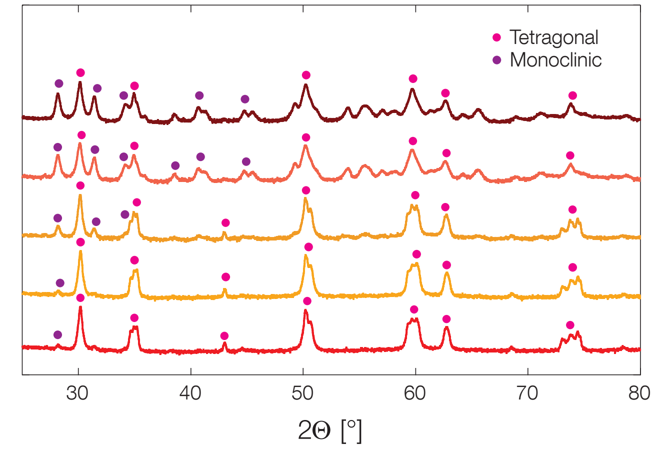
The total porosity and the type of porosity for thermal barrier coatings produced by different powder manufacturing methods.
Intrasplat cracks Globular pores Interlamellar pores



SEM photomicrograph of a typical XCL coating exhibits a high level of interlamellar porosity.

Phase stability testing

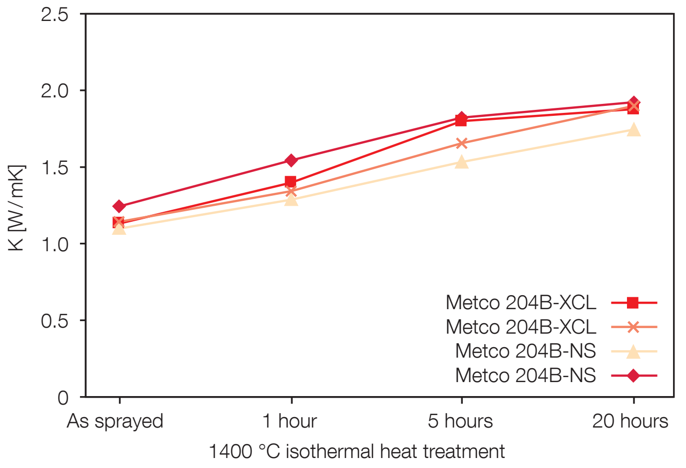
Tests performed to measure phase changes after heat treatment at 1400 °C for 100 hours indicate that coatings of the new material show phase stability that is almost identical to the existing Oerlikon Metco high-purity product.



Material	Tetragonal weight %	Monoclinic weight%
High alumina content	60	40
High silica content	61	39
Metco 204NS	94	6
Metco 204B-NS	98	2
Metco 204B-XCL	98	2

Laser flash thermal conductivity testing

Thermal conductivity tests using laser flash were carried out at 1400 °C. In each test, coatings of the new material compared very favorably to coatings of the existing material products.



Customer benefits

Effective

- Improved sintering resistance at elevated temperatures performs well at higher service temperatures without spallation.
- Stable microstructure enhances coating service life.
- Suitable for use with traditional and alternative stabilizers or as a matrix material for high temperature clearance control systems.
- High level of interlamellar porosity enhances compliance and improves thermal resistance.

Efficient

- Stable material at higher combustion temperatures permits greater turbine engine thermal and fuel efficiency.
- Allow increased time between overhaul of coated hot section components.

Economical

- Highest quality material at pricing comparable to the standard Metco 204 family of materials.
- HOSP material sprays with high deposition efficiency and excellent flowability.
- Little or no adjustment in spray parameters required when switching from other HOSP materials.
- High purity material potentially reduces waste disposal costs resulting from overspray and coating stripping for large-scale TBC coating processors.

Environmental Benefits

- Very low levels of thorium and uranium compared to conventional TBC materials.
- Promotes more efficient fuel burn, for cleaner engine emissions.
- Longer service life reduces overall waste levels.

Information is subject to change without prior notice.

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