



SIEMENS



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Summer UTSR Presentation

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Thermal Barrier Coating Trials

Thermal Barrier Coating (TBC):

- Used to protect metal of blades from high temperatures

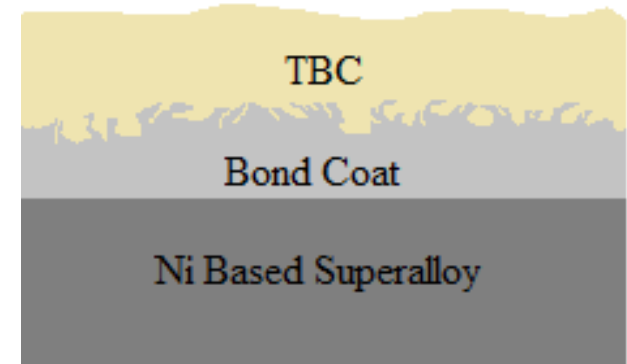
Bond Coat:

- Used to adhere the TBC to the blade's metal surface

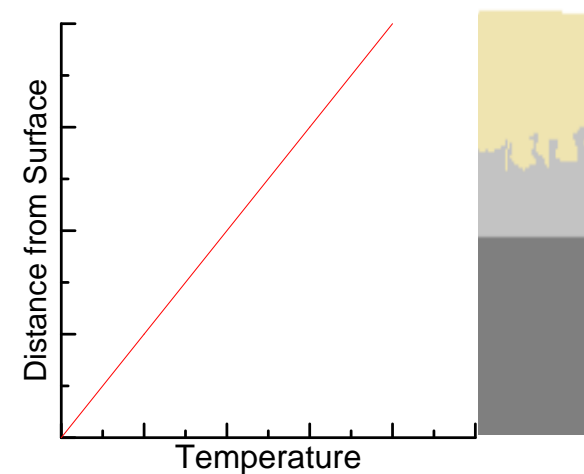
Possible Advancements:

- Higher temperature stability
- Simplifies production
- Longer lifespan

Hot Engine Environment



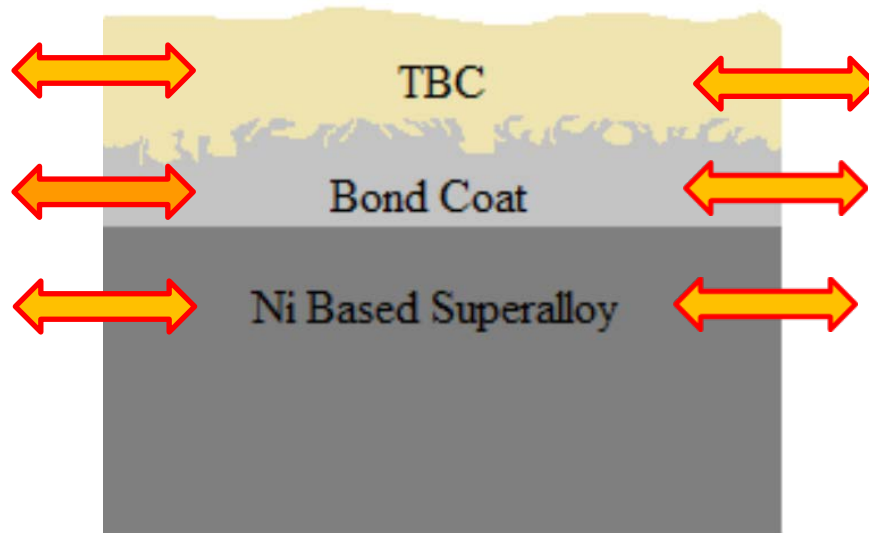
Internally Circulating Cooling Air



Thermal Barrier Coating Trials

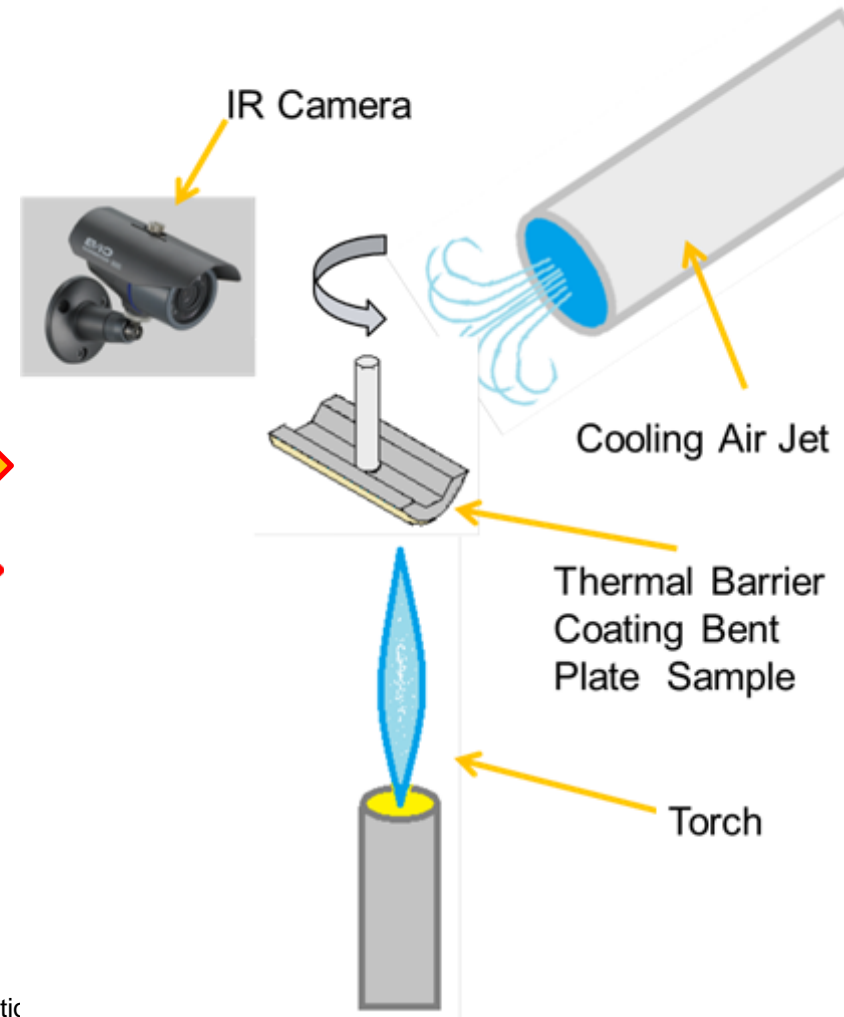
Project:

- Testing new Bond Coat and Thermal Barrier Coating combinations
- Focus on adhesion and expansion characteristic

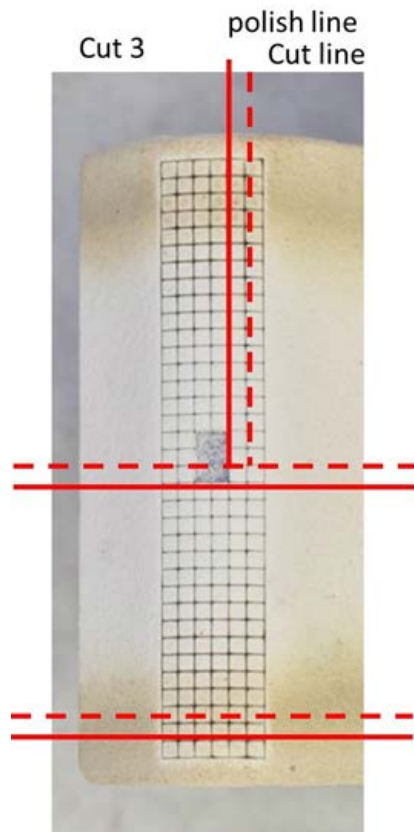


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Testing Rig



Thermal Barrier Coating Trials

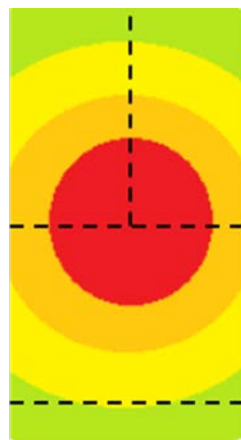


Participation:

- Sample sectioning and polishing in preparation for inspection

Cut 2
Cut line
polish line

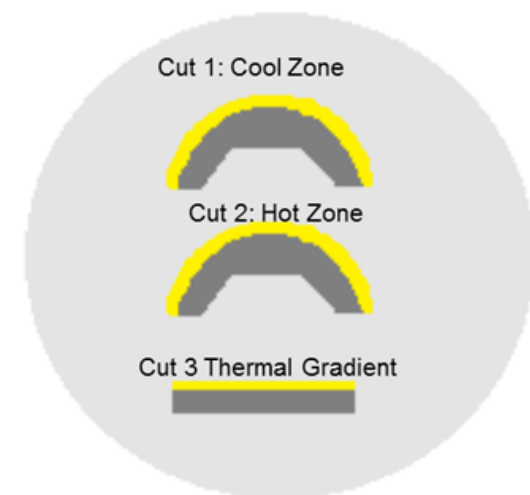
Cut 1
Cut line
polish line



Cut 3: Thermal
Gradient

Cut 2: Hot Zone

Cut 1: Cool Zone



Aged Material Evaluation

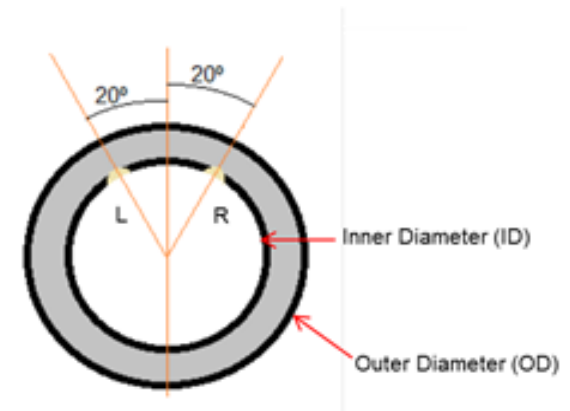
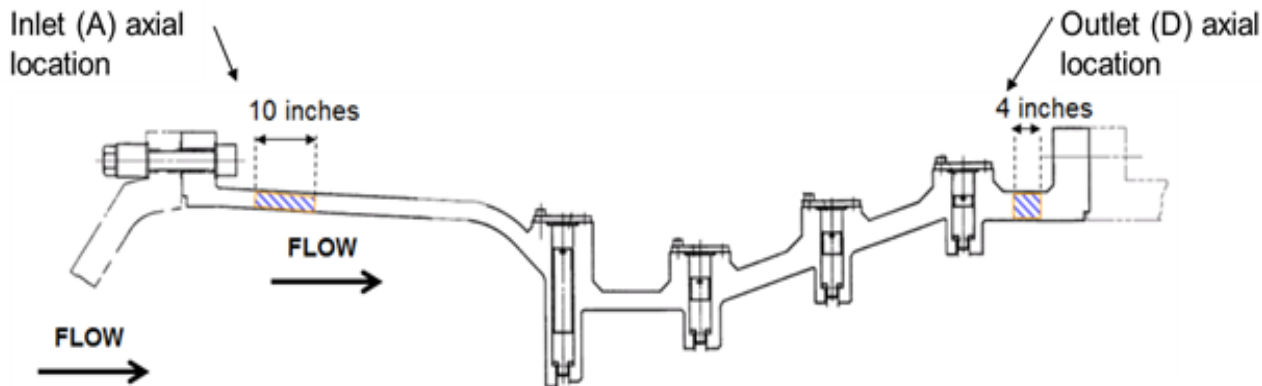
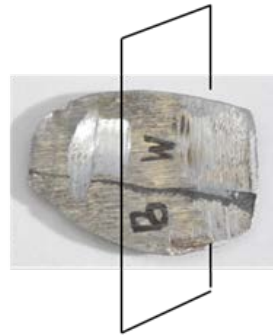
Project:

- Evaluate hazards of continued operation for a turbine casing with **~100,000** equivalent baseload hours

Hazards:

- Graphitization / Spheroidization
- Loss of strength

Cross section location



Aged Material Evaluation

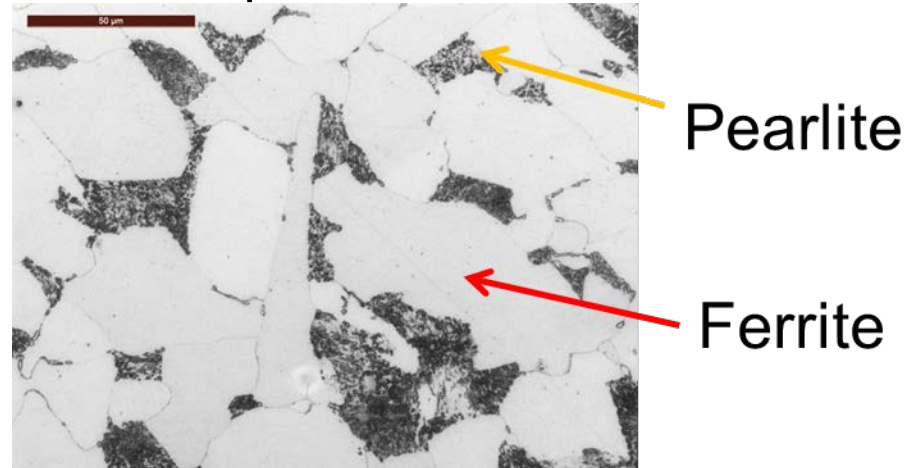
Participation:

- Sectioning and polishing
- Hardness testing and tensile strength estimations
- Etching, Metallography and analysis of microstructure
- Analysis of size and distribution of Graphite nodules

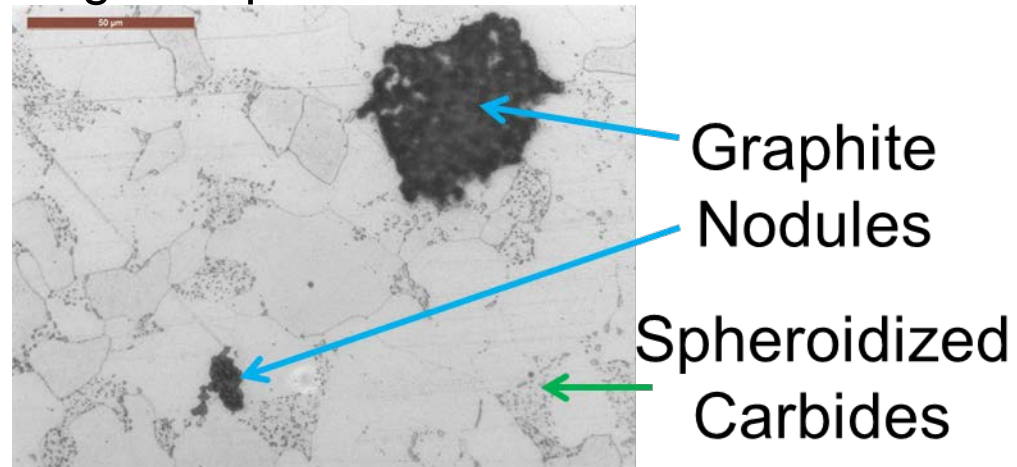
Determination:

- No immediate danger in continued operation
- Indication of development of a possible hazard, yearly re-evaluation advised

Low Temperature Inlet Section



High temperature Outlet Section



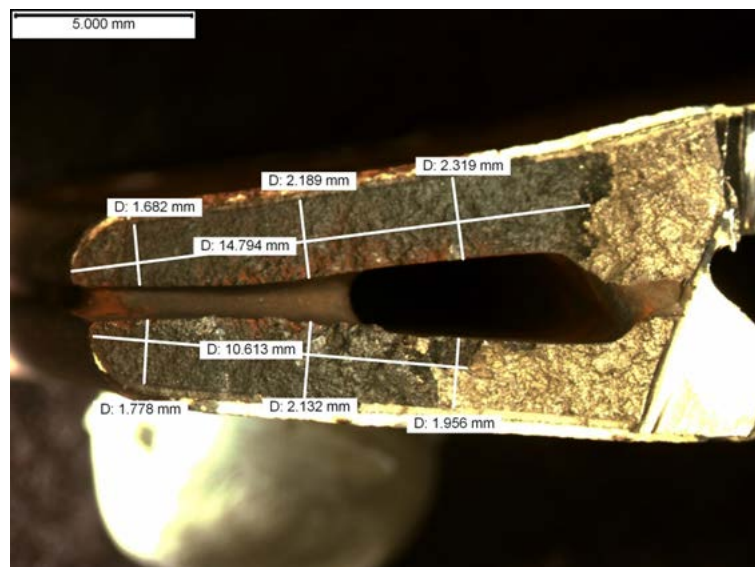
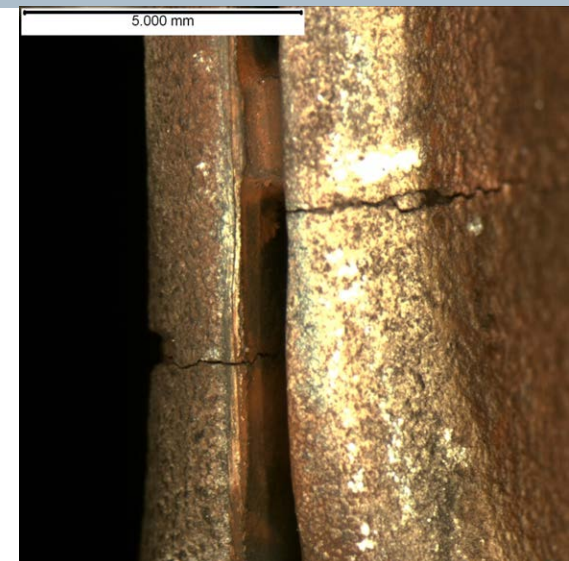
Blade Fracture Analysis

Project:

- Analyze and discover cause of cracking in two Row 2 blades

Participation:

- Sectioning and polishing
- Optical Microscopy

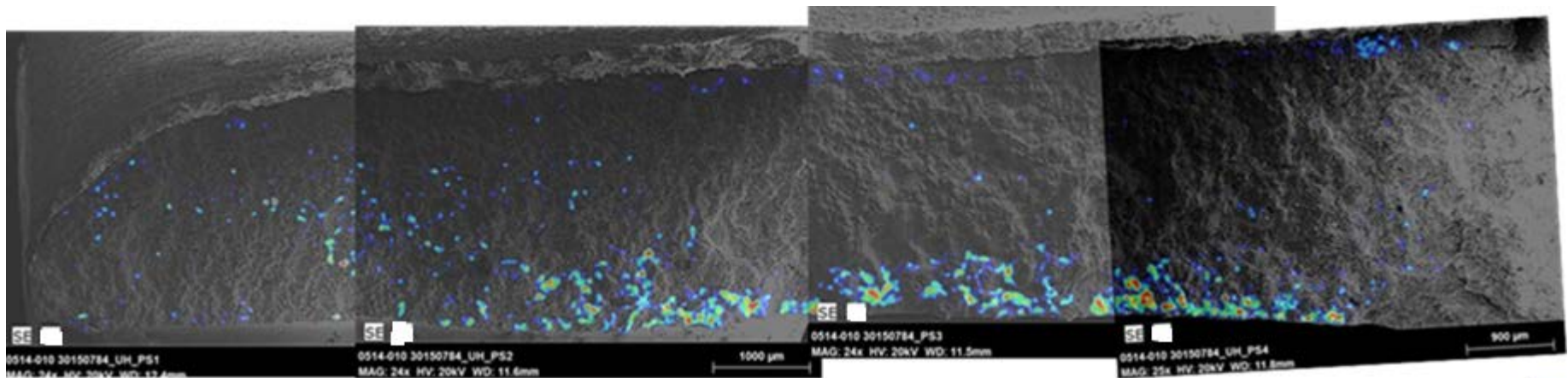
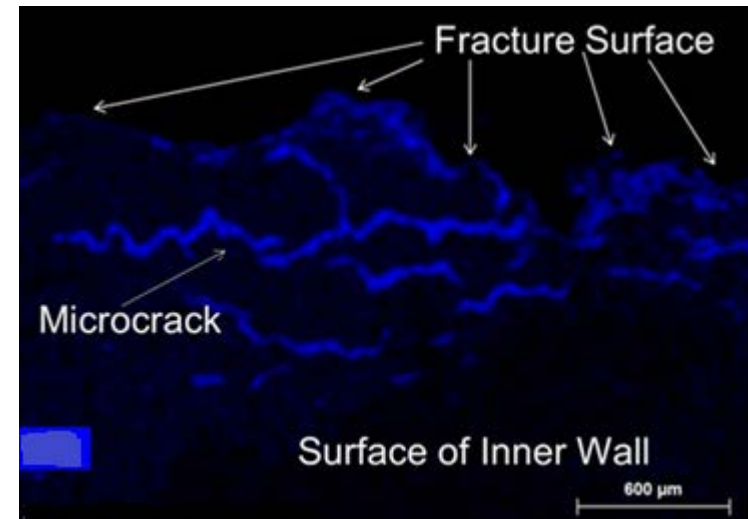


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Blade Fracture Analysis

Participation:

- Scanning Electron Microscope (SEM) Imaging
- Energy-dispersive X-ray Spectroscopy (EDS) elemental mapping.



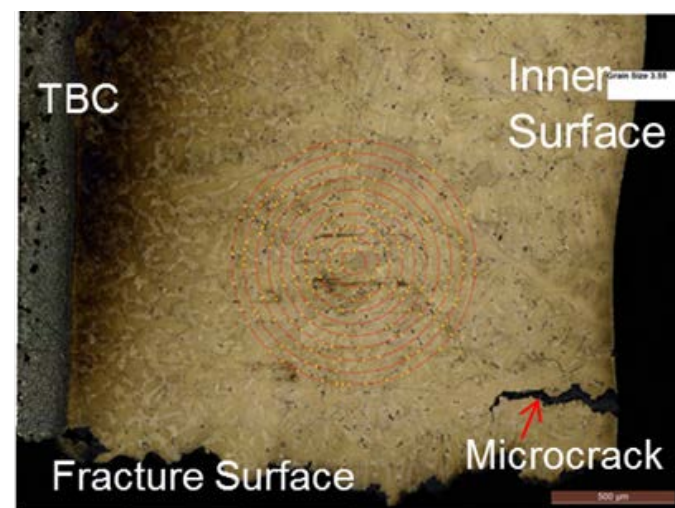
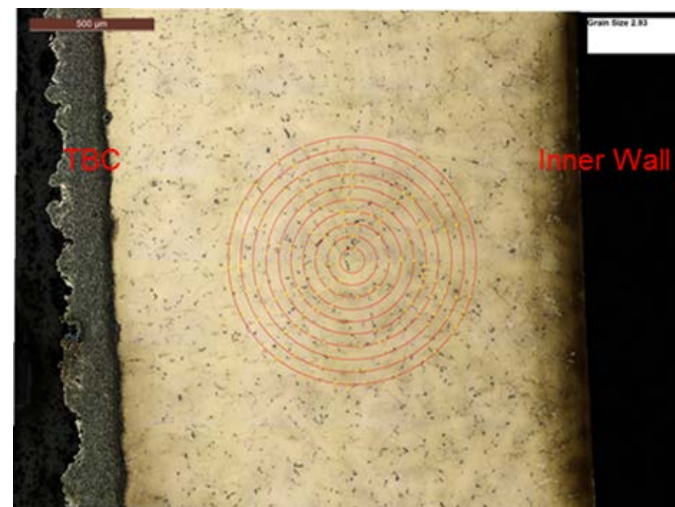
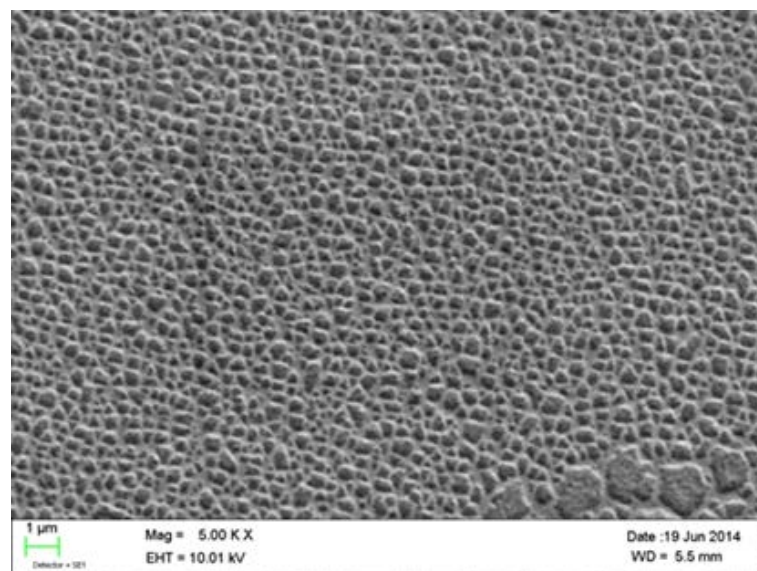
Blade Fracture Analysis

Participation:

- Optical Microscopy and SEM Imaging
- Grain Size Analysis
- γ' Size analysis

Determination:

- No materials flaw detected
- Failure due to overstress in the design



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Questions?

Thank You

TBC Advisors

Dr. Cora Schillig

Neil Hitchman

Fracture Analysis Advisors

Dr. Keneth Star

Dr. Zafir Abdo

Lab Operations Management

Vinay Jonnaladda

Joshua Rolland