Ultra-High Temperature Thermal Barrier Coating Development and Validation

DE-EE0008307

Solar Turbines Incorporated, Solution Spray Technologies LLC

Project Period 1

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Overview

Timeline

- Awarded on 5/25/18
- Kickoff Meeting on 6/28/18
- Project End date of August 2021

Barriers

- Current thermal barrier coatings have debits in maximum temperature limit (1200°C), durability and corrosion resistance

Budget

	2018	2019	2020	2021	Total
DOE Funding	389K	805K	811K	395K	2,400K
Solar Turbines Cost Share	125K	260K	262K	128K	774K
					3,174K

Partners

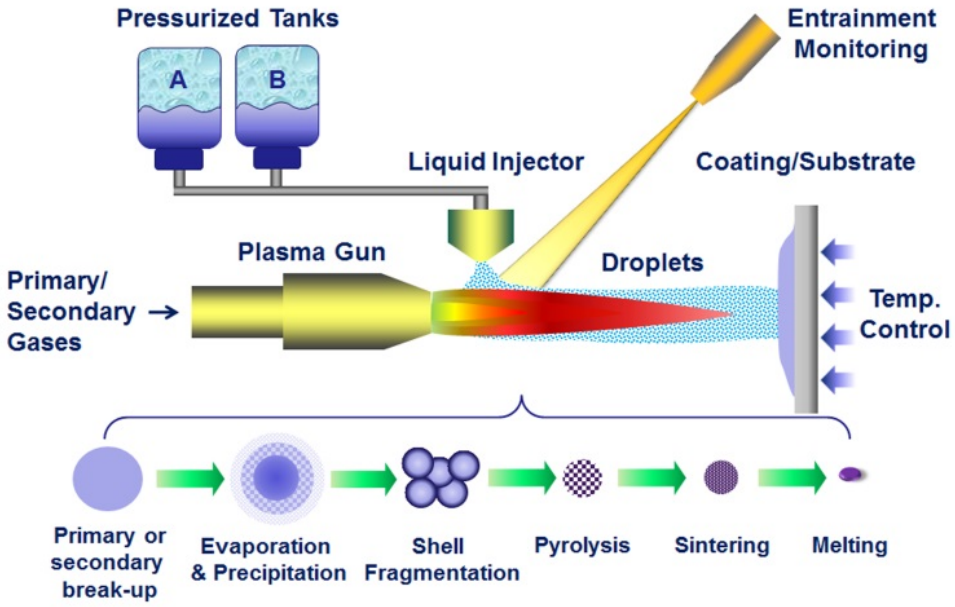
- Solution Spray Technologies LLC (SST)
- SST was formed to develop and commercialize the Solution Precursor Plasma Spray (SPPS) process
- SPPS was originally developed at Univ. of Connecticut with HiFunda under direction of E. Jordan, M. Gell and B. Nair

Project Objectives

- Increasing the efficiency of gas turbines is an important goal for DOE and Mfg industry (to reduce GHG & operating costs)
  - Higher operating temperature results in gas turbines with higher efficiency
  - Current thermal barrier coatings have debits in maximum temperature limit (1200°C), durability, and corrosion resistance
- This Project will implement, improve (process and properties), and demonstrate a thermal barrier coating with +200°C temperature increase
  - Manufacturing improvements with a higher enthalpy torch
  - Optimized coating properties with graded porosity
  - Develop Manufacturing process for full-scale components
  - Rig demonstration of higher temperature limit & durability
  - Development engine test on combustion and turbine components

Technical Innovation

- Solution Precursor Plasma Spray (SPPS) will be used to apply yttrium aluminum garnet (YAG) with unique microstructure characteristics
  - Phase stable crystalline YAG
  - Improved erosion and corrosion resistance
  - Higher thermal cycle durability
  - Lower thermal conductivity
  - Higher temperature capability (+1400 °C)

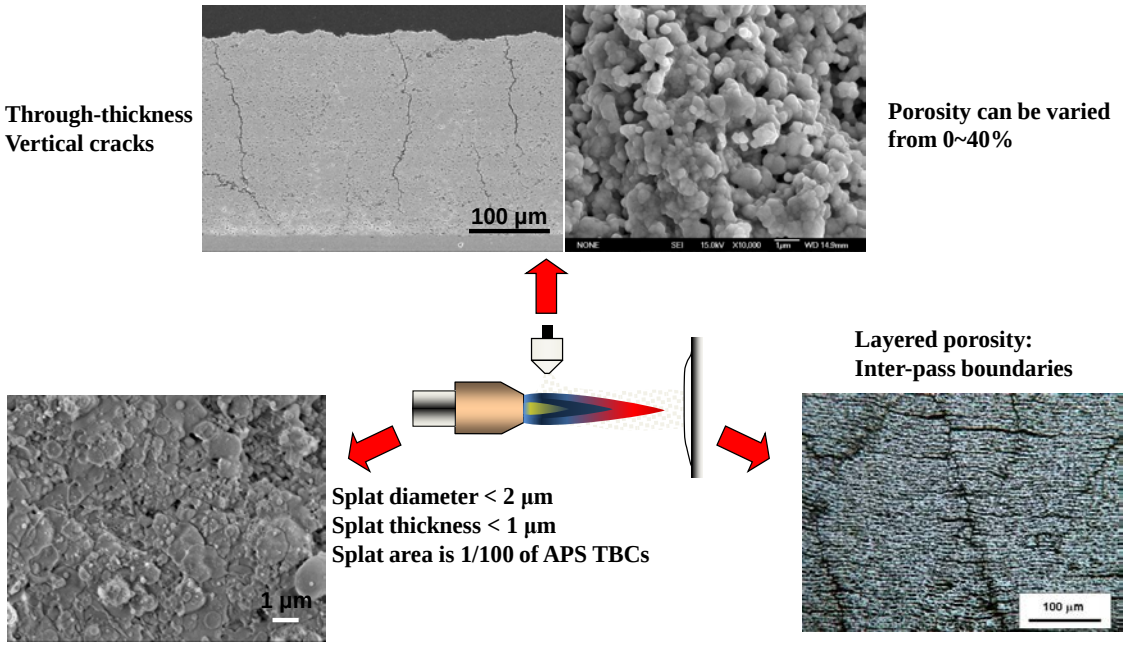


Material Challenges: YAG has lower thermal expansion and higher thermal conductivity

Process Challenges: standoff distance, low deposition rates, part temperature control

Technical Innovation

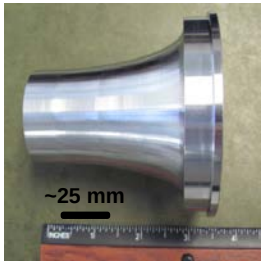
- Generate microstructures with strain tolerant through thickness cracks and porosity - inherent and inter-pass boundaries (IPBs)

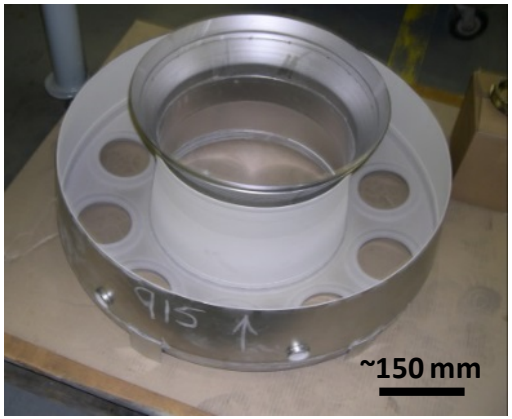


- Prior testing has demonstrated durability in both laboratory and rig testing along with better insulating capability

Technical Approach

- Implement the Solution Precursor Plasma Spray Technology initiated at the Univ. Connecticut/Solution Spray Technologies (SST)
- Improve application process with higher enthalpy torch with SST knowledge
- Develop and improve process for application on gas turbine hardware progressing from combustion injector components followed by more complex liners and turbine components

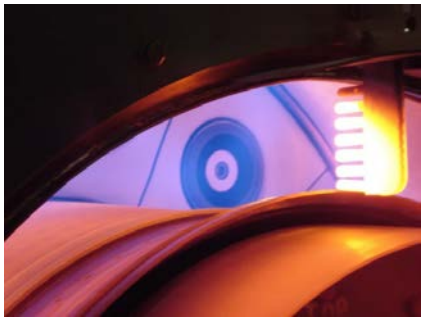


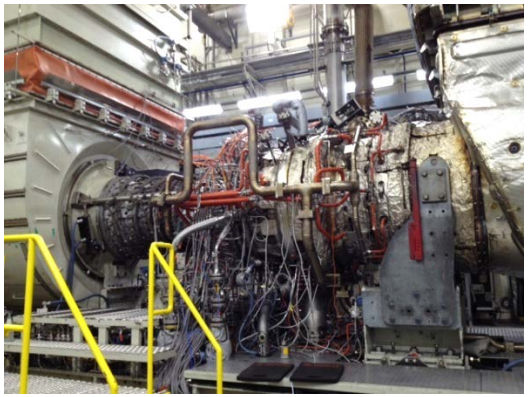


Technical Approach

- Develop processing capability to grade coating porosity to tailor coating properties for specific application
  - Control process settings for continuous porosity grading
  - Increase porosity for abradability and reduce thermal conductivity
  - Decrease porosity to improve resistance to erosion and corrosion
  - Grade coatings for optimal thermal cycling durability

- Demonstrate and validate higher temperature capability and durability in both rig and development engine testing





Planned Milestones

2018

- Solar produces SPPS YAG coatings
- Coatings fabricated and tested with higher enthalpy torch

2019

- Property validation on technology transfer
- Graded coating developed and laboratory tested
- Higher temperature capability demonstrated in rig testing

2020

- Graded coating optimized and rig tested on combustion liners
- Graded coating developed for abradability and rub rig tested
- Components for development engine test coated

2021

- Development engine test performed and completed
- Post condition of coated components evaluated

Transition

- Validate long-term durability of the coating through additional development engine testing and further optimize application process
- Successfully development engine testing will substantiate field trials of the coating technology
- The coating will be evaluated by Solar for other applications
  - Other engine models as upgrades/uprates
  - New engine models as they are developed
  - Other turbine parts (e.g., turbine blades)
- SST will continue to advance the solution precursor coating process and evaluate other potential applications

Questions?