Environmental Barrier Coating

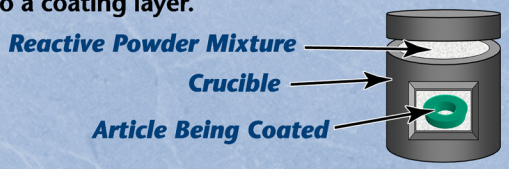
The object of this program is to develop coatings for hot-section components of advanced, high-efficiency microturbines and industrial turbines that resist degradation (surface recession) in high-temperature, high-pressure water-vapor environments.

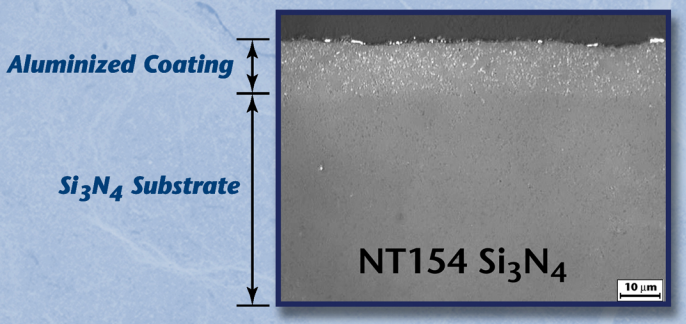
Coating Requirements

- Environmentally stable in the presence of O_2 and H_2O
- Low volatility
- Strong, adherent, and durable
- Matching coefficient of thermal expansion
- Thin and controllable to retain aerodynamics
- Low cost

Pack Cementation Coating (Low-Cost Process)

- Complex-shaped components to be coated are embedded in a reactive powder mixture.
- At an elevated temperature, the powder forms a reactive gas that migrates to all surfaces of the complex-shaped part.
- The chemical reaction and diffusion convert the surface of the part into a coating layer.





Pack Cementation Coating (Variables)

- The coating that is formed during pack cementation depends upon processing time, temperature, atmosphere, composition of the article being coated, and composition of the reactive powder mixture.

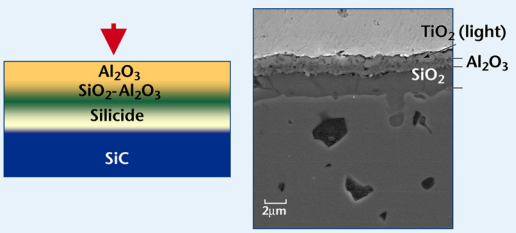
- Some of the conversion coating compounds formed on Si_3N_4 identified by X-ray diffraction analysis.

$SrAl_2O_4$, $Y_2Si_2O_7$, Al_2O_3, Sr_2SiO_4, $ZrSiO_4$

Al_2O_3 Forming Coating

- Metallic coatings like TiCrAl are deposited on Si_3N_4 or SiC and diffuse into the substrate during heat treatment. On exposure to air, the coating oxidizes to form a protective Al_2O_3 coating or scale.

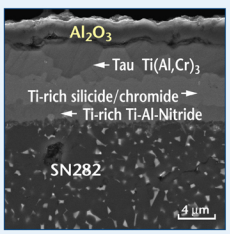
Metallic Coatings Oxidize and Form Protective Alumina



Exposure of 3 µm of Ti-51Al-12Cr sputtered on SiC showed excellent adherence after ten 100-hour cycles to 1100°C in laboratory air. No spallation occurred.

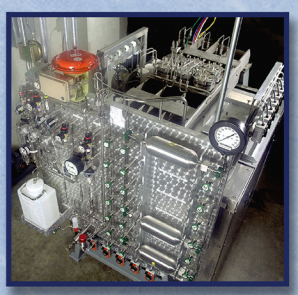
TiCrAl on Kyocera SN282 After Exposure to Three 100-hour Cycles to 1000°C in Ambient Air

All sputter coating provided through collaboration with M. Weaver and F. Huang at the University of Alabama, Tuscaloosa.



Ceramics, Ceramic Composites, and Coatings for Use in Turbine Hot Sections Are Being Evaluated in Simulated Microturbine Environments.

- Temperatures up to1500°C
- Pressures to 30 atm
- Low gas velocity (0.1 m/s)
- Water vapor pressures to 4 atm
- Up to ~60 specimens/run (multiple tubes)



ORNL Low-Flow-Rate, High-Pressure (Keiser) Rig

Contact Information: B. L. Armstrong (armstrongbl@ornl.gov) *Phone* (865) 241-5862
S. D. Nunn (nunnsd@ornl.gov) *Phone* (865) 576-1668
Oak Ridge National Laboratory, Oak Ridge, TN 37831-6065

Office of Distributed Energy and Electricity Reliability

http://www.eren.doe.gov/der/microturbines/microturbines.html

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