



## CeOx Surface Treatment for High Temperature Oxidation Resistance

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U.S. DEPARTMENT OF  
**ENERGY**

National Energy  
Technology Laboratory

# The Need

- Metals exposed to high temperature **oxidize** and **corrode**.
- Many manufacturing and end uses have these conditions which ultimately **limit component life** and **lead to added costs**.
- Treatments and processes to lengthen alloy life can be **expensive**.



# The Solution

- A surface treatment to enhance the high temperature oxidation resistance of alloys
- Several processing technologies exist to achieve this; NETL's method is **simpler**, more **cost effective**, and can be easily applied by **brushing**, **spraying**, or **dipping** to varying component sizes and shapes.
- The treatment can be easily incorporated into the component manufacturing plan.



# The Technology

- **Reduces oxidation rate by 3-5x or more on most metals**
  - Slows scale growth
  - Minimizes internal oxidation
- **Over 75 alloys** have been tested
- **Process involves applying the coating and then allowing the coating to diffuse into the alloy via heat treatment using a furnace.**
- **Estimated cost: \$0.63-1.23 per square foot**
- **U.S. Patent No. 7,553,517: “Method of Applying a Cerium Diffusion Coating to a Metallic Alloy”, issued 6/20/2009.**



Oxidized coupon

# The Competition

	Traditional Alloying Techniques			Existing NiCrAlY, and YSZ, Coating Processes	NETL CeO <sub>2</sub> Coating Process
Process Feature	Pack Cementation of Ce	Ion Implantation of Ce	Melt addition of Ce	Chemical vapor deposition, physical vapor deposition, directed vapor deposition, electron beam evaporation deposition	Brushing, spraying, or dipping
Cost*	\$12.74-15.02 per square foot	~\$1,200 per square foot	\$0.46-2.88 per square foot	~\$1,200 per square foot	\$0.63-1.23 per square foot

## Competitive Advantage

Brushing, coating, or spraying are simpler to perform at lower cost, and can ensure that all surfaces are evenly coated. Producing even coatings is more difficult using the more expensive vapor deposition processes which also tends to be wasteful of valuable materials and limited to line-of sight coverage. This is where the “dipping” variant of the NETL process has a distinct advantage. The ease of recycle of excess coating materials is an additional advantage

Likewise, since the spraying or brushing applications can be made on the shop floor or lab bench (as opposed to a vacuum chamber) these techniques lend themselves to ease of inspectability thus ensuring a high quality coating.

*\*Approximate*

# The Applications

- Any metal component subject to high temperature conditions
- Heat exchangers
- Thermocouples
- Alloys used in:
  - Energy production
  - Manufacturing
  - Chemical processing industries
  - Automotive industry
  - Aerospace industry
  - Military and defense industries



# Partnership Opportunity

**This technology is available for licensing and/or further collaborative research from the U.S. Department of Energy's National Energy Technology Laboratory.**

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