Durable and Low-cost Fractal Structured Multifunctional Coatings for Next Generation CSP # 08525

Highly adherent fractal coatings on low-cost alloys for high temperature corrosion mitigation

1. Impact

The underlying scientific novelty of this project is that of generating multiscale surface topologies on metallic surfaces by tailoring the operating parameters. The proposed concept would enable achieving corrosion rates < 20 μm/year from thermal cycling corrosion tests demonstrating 30-year lifetime for molten salt fluids for next-gen CSP plants operating at temperature > 750°C. Operation at high temperatures also brings down the thermal storage cost due to high energy storage capacity. The combined benefits will enable achieving the DOE SETO cost targets.

2. Project Goal

The overall objective is to develop fractal-textured protective coatings that will reduce corrosion rate and allow conventional, low-cost containment and piping alloys such as stainless steel (SS316, SS347) or Inconel (IN800H) to be used with high temperature (>700°C) heat transfer fluids and thermal energy storage materials such as s-CO_2 and molten chloride or carbonate salts for various CSP thermal components.

3. Method(s)

Fractal coatings were fabricated integrally on low-cost Fe-based alloy substrates by using industrially viable electrodeposition process. The corrosion rates and descaled weight loss were measured on samples subjected to thermal exposure for different time durations in molten salts.

From the EDS line scan spectra, it is evident that the oxide scales are composed of iron, chromium, and nickel. Iron and chromium are significant elements in the alloy and nickel emerges from the surface. The reduced corrosion damage in the etched substrates may be attributed to the formation of stable oxides (Fe_2O_3, $CrFe_2O_4$, NiO) with a large volume to the surface area on the different fractals during initial immersion, which acts as passive layers and prevents further corrosion compared to plain coated substrates.

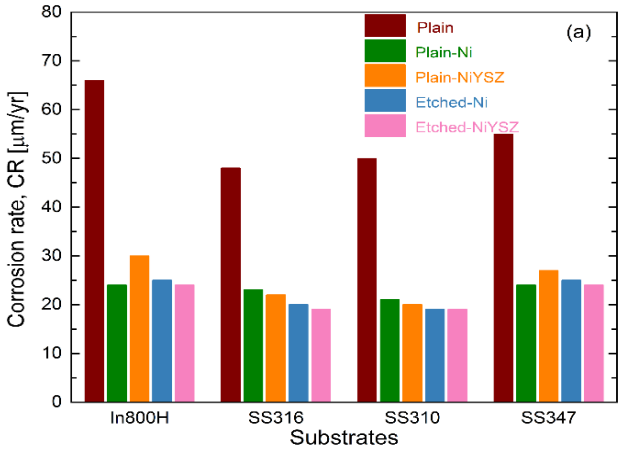

Figure 1. Dramatic reduction in **corrosion rates of alloys with fractal textured Ni and NiYSZ coatings.**

4. Conclusion/Risks

Fractal coatings on plain and etched substrates showed low corrosion rate, well below about 25 μm/y, for low-cost alloys exposed to high temperature molten salts.

5. Team

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