Improving the oxidation resistance of nickel-based superalloys for turbine blades

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What is the role of yttrium in inhibiting oxidation?

High service temperatures of turbine engines enable higher ratios of generated power to fuel consumption. Yttrium has been regarded as a promising element for increasing the oxidation resistance of Ni-based superalloys at high temperatures, Fig. 1. Possible reasons are:

- Mechanical strengthening of the aluminum oxide layer;
- Improving the adherence of the oxide layer to the metal substrate by either desulphurization (forming $Y_2O_2S$ or $Y_2S_3$); that is, inhibiting interfacial segregation of sulfur or by interfacial segregation of $Y$;
- Retarding oxygen diffusion.

**Fig. 1** The temporal dependence of the oxide thickness on oxidation time for the René N’5 (without Y) and N’5+ (with Y) alloys for different temperature-time treatments. The oxide layer of the N’5 alloy (full symbol) is always thicker than for the N’5+ alloy (empty symbol). **Fig. 2** is a SEM micrograph of the metal/oxide interface in the N’5 alloy after oxide spallation during a 100 h heat treatment at 900°C.

Local -electrode atom-probe (LEAP) tomographic analyses of specimens lifted-out from the vicinity of the metal/oxide interface (Fig. 2) will provide us with answers to the following questions, thereby help us determine the role of Y.

- Does Y segregate at the metal/oxide interface?
- Is there formation of clusters, e.g., $Y_2O_2S$ or $Y_2S_3$, in the local vicinity of the metal/metal-oxide interface?
- How does the oxygen concentration vary with distance in the metal oxide thickness?