Atom Probe Tomography Investigations of Oxygen/Nitrogen additions to Aerospace Ti-alloys

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In aerospace gas-turbine engines, there is an ongoing drive to reduce weight and increase engine operating temperature, both of which offer significant fuel-saving benefits. Titanium alloys have proven to be key materials in many engine components, but to achieve new performance gains a deeper, atomic-scale understanding of the alloy microstructures, and how they respond to different environments is necessary.

Atom Probe Tomography (APT) is an excellent tool to provide such information, and has provided a number of novel insights into how species such as oxygen interacts with these materials. Oxygen can cause embrittlement by encouraging formation of nanoscale precipitates of the ordered a_2 phase (Ti_3Al) [1-3]. However significantly more work is required to understand the onset of a_2 phases in different alloys, as well as where oxygen resides in the microstructure.

We will present a multi-technique study using not only APT, but complementary TEM, TKD and EPMA methods considering the effect of oxygen additions to Ti-7Al and Ti-6Al-4V microstructures, examining a range of heat treatments and oxygen contents. Nitrogen too can embrittle Ti-alloys, although the details of this are even less well understood; a similar range of different nitrogen-containing alloys will therefore also be examined. Microstructural changes are also linked to mechanical properties through nanohardness data. Results will be compared to those from parallel, multi-technique studies of oxygen-rich 'alpha-case' layers on Ti-6Al-4V [4], and an ex-service IMI 834 compressor disc, linking model exposures to real components.

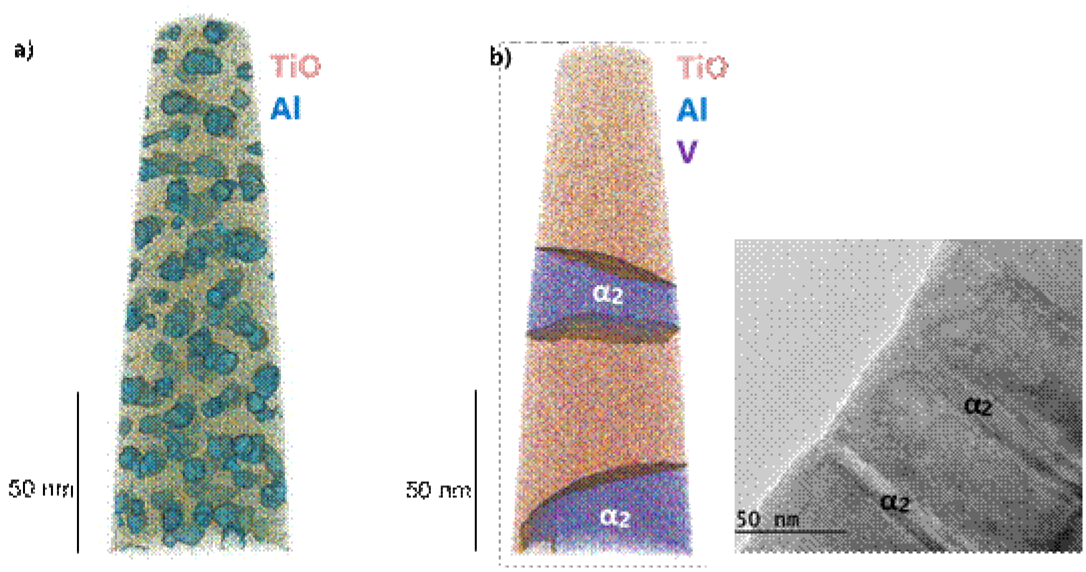

Figure 1 (a) Fig. 1: Atom map of Ti-7Al containing 2500 wppm O aged for 49 days. Φ#177;$_2$ precipitates highlighted using (Al) isoconcentration surface. (b) Atom map (left) and TEM bright field image (right) of Ti-6Al-4V following air exposure at 800°C for 24 hours, showing Φ#177;$_2$ bands formed

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