

Microstructural Study of Fe-Cr-Al-X (X=Nd,Pr) Alloys for High Temperature Structural Applications

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Vibrations are the source noise and reduce the service life of components in aircraft engines. In terms of economy and aircraft engine functioning, vibration damping is one of the major reasons for the search of high-performance materials with high damping capacity [1]. FeCrAl alloys have high strength and good oxidation resistance and they are also strong candidates as damping structural materials for aerospace applications [2]. The excellent oxidation performance of FeCrAl alloys is due to their ability to form Al₂O₃ scales which inhibits the oxidation of the underlying alloy. The microstructure of the Al₂O₃ scale must be compact, uniform and adherent to act as a barrier to oxygen and other contaminants. Rare Earth Metal (REM) additions in FeCrAl alloys could control the microstructure of Al₂O₃ oxide scales enhancing their qualities as barriers [3].

The aim of the present work was to investigate the effect of small additions of Nd, Pr (doping additions), on the microstructure of the as-cast Fe-13Cr-6Al and Fe-20Cr-6Al alloys.

Alloys with nominal composition Fe-13Cr-6Al (136 alloys), Fe-20Cr-6Al (206 alloys) (wt.%) were prepared using pure elements (≥ 99.9 wt % purity) and clean melting with non-consumable tungsten electrode in a copper water-cooled crucible. Metallographic preparation was carried out by conventional grinding with SiC paper and polishing clothing with Al₂O₃. Next, the chemical etching of the polished samples with Marble's reagent was performed to reveal their microstructure. The cast microstructures were characterized using X-Ray powder diffraction (XRD) and Optical Microscopy. The samples were named accordingly to their composition and RE addition 136, 136 RE, 206, 206 RE1, 206 RE2.

The preliminary results in figures 1, 2 and 3, suggest that the as-cast alloys consisted of α Ferrite dendrites. The images of the typical microstructures of the alloys were taken from the center of the ingots and are shown in figures 1 and 2. The microstructures in the all the alloys were very similar and consisted of faceted dendrites of α Ferrite. The 206 RE1 alloy also presented a low volume fraction of circular precipitates (Figure 2b and 3a). The XRD data (figure 3b) suggested the cubic ferrite according to (JCPDS card 03-0867).

References:

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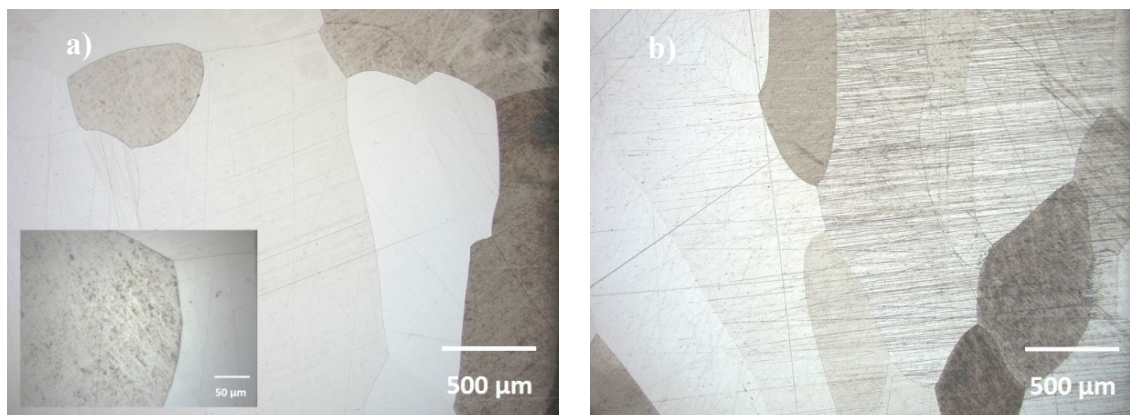


Figure 1. Optical images of typical microstructure of the centre of the as cast alloys, a) alloy 136 at X50, insert alloy 136 at X500, b) alloy 136 RE at X50.

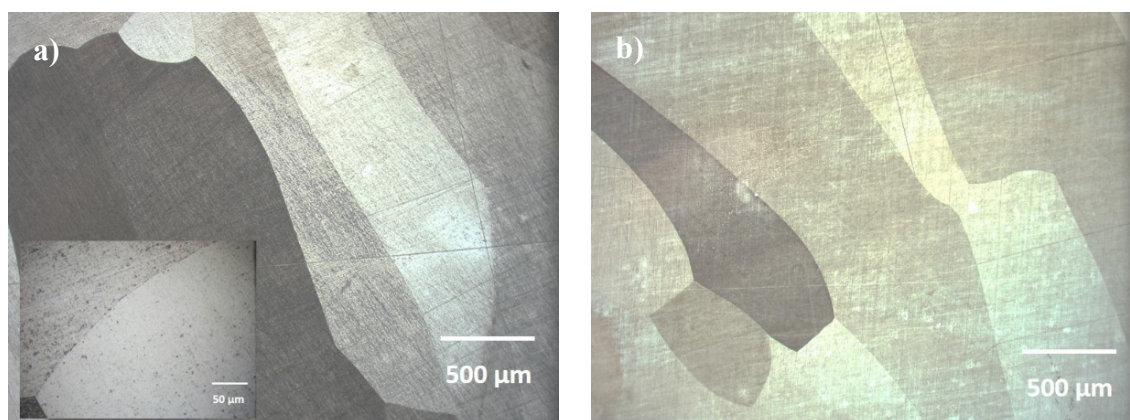


Figure 2. Optical images of typical microstructure of the centre of the as cast alloys, a) alloy 206 at X50, insert alloy 206 at X500, b) alloy 206 RE1 showing precipitates at X50.

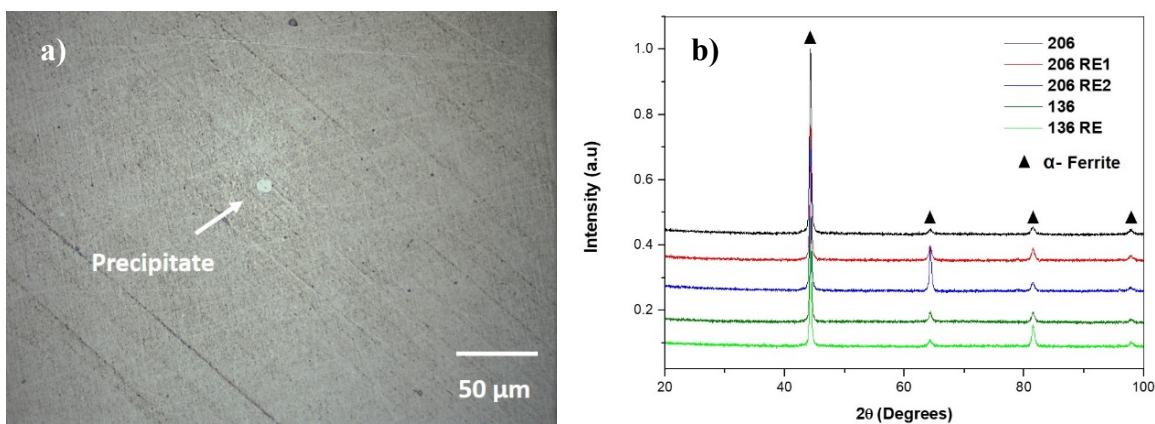


Figure 3. a) Optical image of typical precipitates observed in 206 RE1 as cast alloy at X500, b) XRD diffractogram of all the as cast alloys.