

OR2204

## Control of microstructure of nitrided Ni-based superalloys by plasma based treatments

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Ni-based superalloys, widely used in aerospace, aeronautics but also in chemical industries thanks to their high mechanical and corrosion resistance, were nitrided using two R.F. plasma based facilities, using either floating potential or pulsed high-voltage polarization (PBII at 10 kV). Using low pressures (0,8 to 8 Pa) with various contents of H<sub>2</sub> and N<sub>2</sub>, the nitriding treatments were performed with temperature ranging from 350 to 650°C for several hours. The studied Ni-based superalloys were: Haynes®230, composed of a polycrystalline austenitic-like FCC Ni phase  $\gamma$  hardened with solid solution of alloying elements, the main one being Cr ( $\approx 25$  at%); Udimet 720Li, a similar polycrystalline  $\gamma$  phase but strengthened by a high fraction of ordered FCC precipitates  $\gamma'$  (Ni<sub>3</sub>(Ti,Al,Ta) type), with a multimodal sizes distribution (from few  $\mu\text{m}$  to few 10s nm); MC2, a single crystal  $\gamma$  phase matrix with coherent  $\gamma'$  precipitates of cuboidal shape. Depending on the composition or microstructure of the materials and on the nitriding treatments parameters, various behavior can be obtained: non-nitrided  $\gamma'$  precipitates, formation of the expanded nitride austenitic phase  $\gamma_N$ , like in low temperature nitrided ASS, chromium nitride (CrN) and/or possible other nitrided phases (like TiN, Ni<sub>4</sub>N...). In addition to macroscopic characterizations like XRD and GDOES, accurate investigations were conducted by SEM (EDS), TEM (SAED, EFTEM, EELS) or tomographic atomic probe to clearly identify the distribution of the nitrogen distribution at the nano-scale. It was moreover demonstrated that the high nitriding potential conditions (high temperature, high nitrogen content with few hydrogen) favor the CrN or  $\gamma_N$  phase, whereas PBII nitriding, reaching same results without use of hydrogen, enables the elimination of CrN thanks to the surface ion sputtering.

### Keywords

nitriding  
Ni-based superalloy  
microstructure  
PBII