Elastoplastic responseofNi-basedsuperalloys under plasma nitriding

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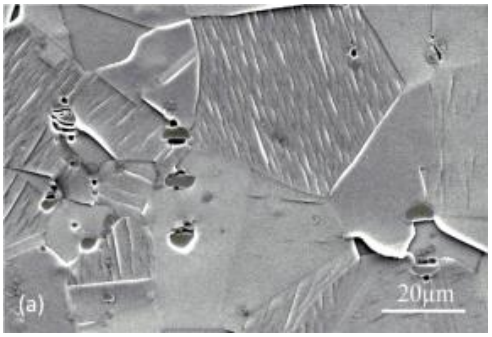

Surface of Haynes230after nitriding

Ni-based superalloys are composed of a matrix with an austeniticface-centred cubic (FCC) crystal structure (γ phase) which is generally strengthened by the presence of a high fraction of ordered FCCmicro/nano-precipitatesγ′ (Ni_3(Ti,Al) type). Plasma assisted nidriding of various Ni-based superalloyshas been performed at moderate temperature (400°C) to shed light on the specific responses of the different phases under nitriding[1]. It has been demonstrated that the γ phase is nitridedsimilarly to austenitic stainless steels (ASS),to form the expanded austenitic phase γ_N, a nitrogen insertion solid solution, with ~25 at.% N, but also CrN. γ' phase exhibits different behavior depending onthecomposition:γ'with high Ti/Al ratio arenitrided in similar proportion to the γmatrix, while, γ'with low Ti/Al ratioare not or poorly nitrided. The nitrogen incorporation leads to an expansion of the nitrided layer in the direction perpendicular to the surface, resulting in the swellingof the material surface during nitriding. As in ASS[2], swelling is expected to result from the lattice expansion due to theincorporation of nitrogen (to form the expanded phase $\gamma_N$and nitrides)but also fromelastic and plasticdeformationscaused bythe induced residual compressive stress. If slip bands were clearly observedon the surface of a γsingle-phasealloy(Haynes 230, see figure),it is not the case for the γ/γ′two-phase alloys studied (Udimet 720Li, MC2), for whichthe high fraction of γ' could explain why dislocations do not emerge onto the surface.Complementary Transmission Electron Microscopy investigations have been performed on the MC2 single crystal superalloy to understandthe respective elastoplastic responseofboth phases and the modification of theγ/γ′ interfaces under nitriding.

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2. Stinville J., TemplierC., VillechaiseP., PichonL., Journal of Materials Science 46, 5503–5511, 2011