Microstructural characterization of plasma assisted nitrided nickel based superalloys: nitriding response of γ matrix and γ' precipitates

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Nitriding can be used as an efficient surface treatment to improve the mechanical, tribological or corrosion resistances of Ni-based superalloys. These alloys are composed of a matrix with an austenitic FCC crystal structure, called γ phase, which is generally strengthened by the presence of a high fraction of ordered FCC precipitates γ' (Ni_3(Ti,Al,Ta) type). The present work is focused on characterization at the submicrometric/nanometric scales of the chemical and structural modifications induced by low temperature (400°C) plasma nitriding of two nickel-based superalloys: Udimet720Li and MC2. Previous macroscopic characterizations have demonstrated that in both materials the γ phase was nitrided to form the expanded austenitic phase γ_N, a nitrogen insertion solid solution with about 25 at.%N. γ' precipitates was shown to exhibit different behaviour: in Udimet720Li, γ' seems nitrided with similar concentration than the matrix γ, while γ' in MC2 seems poorly nitrided. In this work, characterizations by SEM, TEM, HAADF-STEM, EELS and EDS, have been performed to provide complementary information about the specific response of γ and γ' and understand the origin of the different behaviour of γ' in the two alloys. The macroscopic results have been confirmed with, in addition, observation of nanometric CrN precipitates in the γ_N phase and formation in the nitrided γ' of Udimet720Li of two phases which are still to be determined.