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Low temperature plasma nitriding induced decomposition in AISI 304L austenitic stainless steel

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Plasma nitriding of austenitic stainless steel (ASS) at moderate temperature (~400°C) produces a modified near surface layer, often called S phase, which shows significantly improved tribological properties, conserved or improved (electro)chemical properties and induced ferromagnetism. Here, the study of the nature of the S phase in nitrided ASS 304L is presented. A combination of global probes (X-ray diffraction (XRD), nuclear reaction analysis, glow discharge optical emission spectroscopy) and local probes (field ion microscopy, extended x-ray absorption fine structure spectroscopy) is employed to reveal the phase structure, morphology, atomic ordering and chemical environment. While XRD shows only the presence of the presence of the S phase, the local analysis techniques consistently demonstrate the heterogeneous nature of the nitrided layer. It consists of nanometric CrN precipitates embedded in a Fe_4N-like matrix. The size of the CrN precipitates is found to be larger at the surface than at the nitrided layer-steel interface. Moreover, X-ray spectroscopic investigations disclose three different intermetallic distances and different chemical environments for Fe, Cr and Ni, accompanied with a large static disorder. These findings suggest that the presence of the interstitial nitrogen can destabilize the homogeneous matrix element distribution in ASS 304L even at the rather low temperature of 400°C. Based on the heterogeneous nature of the S phase revealed in plasma nitrided ASS 304L, an alternative insight into its remarkable combination of properties is presented.

Keywords
plasma nitriding
austenitic stainless steel