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THE MARTENSITE TO AUSTENITE TRANSFORMATION BY DIFFUSION OF INTERSTITIAL ATOMS

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SUMMARY

Nitrogen and/or Carbon layer enrichment processes are widely applied in martensitic stainless steels to improve tremendously the tribological properties of the layer, such as hardness and wear resistance. After the interstitial atoms' insertion into the bulk of the martensitic stainless steel, metastable phases called "expanded martensite" (α'_N, α'_C or $\alpha'_{N/C}$) and, under certain treatment conditions, "expanded austenite" (γ_N , γ_C or $\gamma_{N/C}$) are obtained as a direct result of the lattice expansion caused by the inserted interstitial atoms. The obtained austenite after the thermochemical treatment is formed due to the insertion into the bulk of austenite stabilizer elements, that could run the expanded martensite to expanded austenite transformation, called as "martensitic austenite." The term "martensitic austenite" has not become popular and the austenite formed from a martensite phase is, generally, simply called as "expanded austenite."

Critical pieces of information about the martensite to austenite transformation in steels by diffusion of interstitial atoms are scattered in the scientific literature, and since its existence was questioned scarcely in 2012 and lately confirmed in 2017, many important conclusions lie in papers related to austenite stabilizer ions diffusion published before those dates. The present paper aims to accurately show a comprehensive overview about the complex formation of "martensitic austenite" (conditions, limitations, mechanisms, etc.) and link results from other papers to extract new conclusions after an extensive survey on academic literature.

A heuristic review on the BCC to BCT transformation of martensite due to atomic percent of nitrogen or carbon was carefully carried out and how the transformation reflects on an XRD pattern was described. The martensite (BCT) to austenite (FCC) transformation was covered based on recent papers and the consistent conclusions obtained were therefore expanded to past papers published before the martensitic austenite was firstly reported.

After carefully analyzing the transformation from martensite to austenite during the diffusion of interstitial atoms, the following points can be succinctly summarized:1) There is a specific critical amount of atomic percent nitrogen – and most likely carbon – that unstable the martensite and transforms it into martensitic austenite; 2) The BCC martensite firstly has its c/a ratio increased, turning into the BCT state, and then it transforms into FCC martensitic

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austenite; 3) Alloying elements change the critical at.% value typically based on Ni_{eq} and Cr_{eq} elements in the chemical composition; 4) The preferential 2θ diffraction angles for martensitic austenite most likely are around 2θ=41.2º and 2θ=48º, but a large amount of initial retained austenite (or reversed austenite, for tempered martensitic steels) change the peaks position substantially; 5) For long treatment times and/or elevated temperatures, the expanded martensite peak tends to return to greater 2θ angles.

Keywords: layer enrichment processes; martensitic austenite; phase transformation; XRD analysis