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# In situ Observation of Layer Growth During Low Energy Nitriding of Austenitic Stainless Steel

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Investigating the formation of expanded austenite has resulted in several, different models trying to explain the particular diffusion and phase formation behaviour. However, only *ex situ* information, influenced by cooling and annealing processes of the samples after ion implantation has been available until now.
Here, for the first time, the time and temperature dependent layer growth is reported using *in situ* XRD measurements obtained from low energy broadbeam nitrogen ion implantation into polycrystalline austenitic stainless steel 304 in the temperature range from 300 to 500 °C for a process time of up to 1 hour. Expanded austenite was observed at all temperatures without any CrN, in agreement with already published lifetime data for this metastable phase. During the implantation process, a time and temperature dependent lattice expansion is observed. However, during the cooling phase after the implantation, a strong relaxation and peak narrowing is found depending on the cooling rate, indicating a strong influence of stress and stress gradient within this surface layer. Additionally, the layer growth was derived from the time evolution of the substrate peak intensity. At sufficiently high current densities, an inverse parabolic growth law was found at all investigated temperatures. Using the temperature dependence of the layer growth, an activation energy of nearly 0.8 eV was estimated for the nitrogen diffusion.

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