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Stainless steel patterning by combination of micro-patterning and driven strain produced by plasma assisted nitriding

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Plasma assisted diffusion treatments are based on the diffusion of nitrogen and/or carbon in a metallic material at moderate to elevated temperatures. It is known that below 420°C, a plasma assisted nitriding treatment of austenitic stainless steel produces a phase usually called expanded austenite. Expanded austenite is a metastable nitrogen supersaturated solid solution with a disordered fcc structure and a distorted lattice. The nitrided layer with the expanded austenite is highly enriched in nitrogen (from 10 to 35 at%) and submitted to high compressive residual stresses. From mechanical consideration, it is shown that the only possible deformation occurs in the direction perpendicular to the surface. Such an expansion of the layer from the initial surface of the substrate to the gas phase is used here for surface patterning of stainless steel parts.

The new concept of surface texturing or surface patterning on austenitic stainless steel by plasma assisted diffusion treatment will be presented in this communication. The surface patterning was previously shown to be possible by using masks and multi-dipolar plasma nitriding. In this communication, we will present the results obtained by combination of micro-patterning and multi-dipolar plasma nitriding. For that purpose, masks were realized in the clean room of the LPN-CNRS laboratory. Firstly, the PECVD technology was used for deposition of a silicon oxide layer (thickness: 300, 500 and 800 nm) on polished austenitic AISI 316L samples. After a photolithography step performed using the AZ5214 photoresist and a specific mask containing different micro structured configurations, a dry etching process of the silicon oxide layer was performed in a SF_6/CHF_3 plasma mixture. The residual photoresist was removed in a final step consisting in oxygen plasma cleaning. For the final nitriding treatment, we use a multi-dipolar plasma, arranged in a two-dimensional array, belonging to the new generation of low-pressure, high-density plasma sources providing independent substrate biasing and independent ion flux and ion energy control. The resulting plasma diffuses towards the substrate-holder that can be independently heated and/or biased. It is thus possible to carefully control the sputtering of the sample surface.

Keywords
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