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Surface mechanics and wear resistance of supermartensitic stainless steel nitrided by plasma immersion ion implantation

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Abstract

In materials employed in the marine oil extraction, a nitrided layer produced by plasma immersion ion implantation (PI3) can improve the surface resistance against abrasion and still work as a strengthened substructure for deposition of hard coatings. PI3-modified supermartensitic stainless steel (SMSS) surfaces consisted of an iron nitride-rich case followed by N-solid solution; thicknesses of both regions grew as the treatment temperature increased from 300 to 400 ºC. The amount of nitrides scaled up with ion fluence/temperature. The thickest layer (25 μm) with the highest hardness profile (13 GPa) was produced at 400 ºC, as a result of mixed iron nitrides precipitated in the matrix. Elastic recoveries after normal and tangential loadings were improved as well. Moreover, specific wear rates reduced up to two orders of magnitude and the coefficient of friction was 60% lower when compared with that of the untreated surface. Wear features varied from adhesive to abrasive as iron nitrides became the prevailing structure on the modified surfaces, from 300 ºC to 400 ºC. Even so, all the nitrided layers disclosed an overall ductile character under deformation. Nanomechanical analyses indicated that nitrides-containing top layers originated in the implantation and diffusion-based PI3 method were uniformly hardened in depth, in contrast with those from the conventional plasma nitriding.