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Tribological properties of stainless steel surface layer enriched with rare earth elements

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Austenitic stainless steels with their excellent corrosion resistance are used in industrial applications for example: nuclear and petrochemical industry, pulp and paper chemistry, food and chemical processing. Simultaneously stainless steels have low hardness and poor tribological properties, what limited their applications in engineering fields. Improvement of the wear resistance of austenitic stainless steels can be achieved using different surface treatment, for example: re-solidification techniques or enrichment of the surface layer with reactive elements. The aim of the presented work was to improve the wear resistance of AISI 316L steel by incorporation Ce and La elements to its near surface region. Two methods were used for surface layer modification: (i) REE ion implantation: 65kV and nitrogen as the working gas up to REE doses in the range of $1 \times 10^{15} \text{ cm}^{-2}$ to $5 \times 10^{17} \text{ cm}^{-2}$, (ii) high intensity pulsed plasma beams in deposition by pulse erosion (DPE) mode with pulse energy density of 3.0 J/cm^2 , duration in μs range and nitrogen as the working gas. The near surface layer with thickness in μm range was melted and simultaneously doped with REE. Heating and cooling processes were of non-equilibrium type. Various parameters of the process were set up to get level of doping between 0.3- 3.0 at % REE. Surface morphology changes were observed by scanning electron microscopy (SEM). Elemental analysis with EDS method confirm introduction of REE to the modified surface layer. Phases presented in initial and modified materials were identified by X-ray diffraction analysis (XRD). Tribological properties were investigated using Amsler method. An improvement of the wear resistance by a factor of about 2.0 was observed in both methods applied as compared to the initial material.

Keywords

high intensity pulsed plasma beams (HIPPB)
ion implantation
rare earth elements (REE)
tribological properties