ABSTRACTS

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Combined Titanium Plasma-Assisted and Low Voltage Nitrogen Implantation of AISI304 Stainless Steels in an Immersion Configuration

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Low-temperature plasma nitriding is a common and well accepted technique to modify the surface properties of austenite stainless steels such as AISI304 by forming a relatively thick expanded austenite layer without the precipitation of CrN phases on the top surface. Low-voltage nitrogen plasma immersion ion implantation (PIII) has also been demonstrated to be quite effective and flexible. In order to increase the modification efficiency, we combine low-voltage nitrogen PIII with titanium plasma deposition/implantation, as the presence of Ti can further enhance the surface properties of stainless steels. This is because the presence of titanium on the surface not only improves the nitrogen retained dose (by reducing sputtering effects) but also forming strong nitride in the surface region. A titanium plasma is generated in a vacuum arc source and the Ti ions, after passing through a curved duct for filtering and elimination of macro-particles, are implanted / deposited onto the surface of the samples. In our experiments, the sample is immersed in a nitrogen plasma, and so nitrogen is absorbed / implanted into the substrate during low voltage PIII. The nitrogen plasma treatment is conducted at 400°C that is maintained without external heating and only by the energy imparted by the implanted ions to the targets. During low voltage PIII the pulsing frequency of the metal arc source can separately be adjusted to achieve controlled implantation and / or deposition rate of titanium and optimum the processing technology. The sample temperature is directly measured by an in-situ thermocouple-based device designed in our laboratory. The treated samples are characterized by glancing-angle x-ray diffraction, elemental depth profiling, microhardness measurement, and wear/friction test to elucidate the effects of the titanium plasma on the dynamics and efficacy of low-voltage nitrogen plasma immersion ion implantation.