Corrosion resistance of Cr and Cr-N thin films produced by hollow cathode discharge and plasma immersion ion implantation and deposition

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The benefits of PIII process are extended when the implantation process is associated with the formation of thin films and it became a hybrid technique that includes implantation and deposition phases, known as plasma immersion ion implantation and deposition (PIII&D). Chemical, physical and mechanical properties of thin films, especially adhesion, stress and hardness, are changed when plasma implantation is applied on thin films during or after their growth. The process in this study associates a hollow cathode discharge PIII and magnetron sputtering deposition, associating iPVD process with plasma implantation. High voltage glow discharge generates high-density plasma, which ionizes some metal atoms coming from the metal target. The HV pulses are also applied in samples, which leads to implantation of Cr ions during “on” pulse and deposition during “off” pulse. The association of hollow cathode discharge PIII and magnetron sputtering deposition produces thin coatings with very low defect density. Compared with elements of the 4th and 5th groups of periodic table, Cr and other transition metal elements of the 6th group are more difficult to react with nitrogen. N-doping of pure Cr results in a Cr-N binary system that presents two stoichiometric nitride phases, CrN and Cr_2N, even a mixture of these phases with pure Cr or a Cr-N solid solution, and it can be managed by controlling the ion dose or ion energy during the implantation process. Films were deposited on carbon steel from pure Cr target and pure Ar or N_2 and Ar gas mixture. Their corrosion resistance, chemical composition and surface morphology before and after corrosion tests were evaluated by polarization tests, XPS and FE-SEM. Corrosion tests showed that pure Cr and Cr-N films produced by this method increase the corrosion potential and decrease the corrosion current density about 2 orders of magnitude, improving the corrosion resistance of carbon steel, when compared to non-coated sample.