Novel surface modification techniques based on plasma based ion incorporation

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Plasmas have been used for surface modification for quite some time. The modification is primarily done by the ions. When the substrate is biased ~ - 1 kV, the plasma forming gas is a mixture of N\textsubscript{2} and H\textsubscript{2} at pressure ~ mbar, an intense plasma is formed around the substrate. The plasma alongwith ions also supplies excited radicals and energetic neutrals to the substrate surface [1]. If the substrate is heated the diffusion of nitrogen takes place to large depths. For steel substrates, the iron and chromium nitrides take place. These nitrides increase the hardness, wear resistance and for most steels also the corrosion resistance simultaneously. This process is commonly known as glow discharge plasma nitriding. Incorporation of nitrogen can also be done if the plasma is formed at a low pressure using auxiliary sources, e.g., inductively coupled plasma, and the substrate is biased negative to high voltages. This is the process of plasma based ion implantation (PBII). A novel phase formed by this process is expanded austenite in austenitic stainless steels by nitrogen incorporation at temperatures below 400 C giving enhancement in wear resistance without decrease of corrosion resistance [2]. PBII can be mixed with deposition leading to the process of implantation and deposition simultaneously [3]. Using a judicious mixture of pulse on time, duty cycle and bias magnitude, the compressive stress in the coating can be controlled, without increasing the bulk temperature. Such coatings are more adherent to the substrate. The bias can also be suitably used to modify the surface making nanopatterns. Such nano-patterned surface can be coated preferentially on the nano-hills for new optical properties [4]. The presentation will cover all the processes described above alongwith case studies.