COMPOSITE NITRIDED + Ti(N,C,O) TYPE LAYERS PRODUCED BY PAMOCVD PROCESSES

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The rapid technical development enhances the demands for constructional materials with better mechanical properties, resistance to frictional wear, resistance to corrosion and erosion etc. These demands can be satisfied by e.g. applying surface engineering techniques, which permit modifying the microstructure and the phase and chemical composition of the surface layers formed on treated parts, and thereby, as the final effect, modifying their properties. A prospective line of the development of the CVD methods is the production of multicomponent and composite layers with the use of new gaseous atmospheres, such as vapours of organic compounds, as the source of the elements that form the surface layers [1-3], and by producing coatings on previously nitrided substrates using the CVD methods.

In the present experiment aimed at producing surface layers of the Ti(N,C,O) type we used the tetraisopropoxytitanium vapours - $Ti(OiC_3H_7)_4$ mixed with hydrogen and nitrogen and activated electrically under glow discharge conditions (PAMOCVD process). When used in a MOCVD process without the electric activation, this atmosphere only gives TiO_2 layers [2], whereas tetraisopropoxytitanium mixed with ammonia or nitrogen used in an electron-cyclotron resonance plasma process gives high quality TiN layers [4]. This demonstrates how the role of the various active particles that appear when the gaseous atmosphere is subjected to electrical activation is important for the formation of the surface layers. For instance, under the conditions of a glow discharge ignited in the $Ti(OiC_3H_7)_4 + H_2 + N_2$ atmosphere, the active Ti^+, TiO^+, CN, O, N^+, NH, N_2^+ and N particles undergo chemisorption and, since they participate in chemical reactions, permit Ti(N,C,O) coatings to be synthesised with their chemical composition controlled by the process parameters and by the contribution of the nitrogen present in the diffusion-type nitrided layer formed previously on the steel substrate [5]. The action of the active particles of the atomic nitrogen or hydrogen type under glow discharge conditions may also be utilised for modifying the chemical composition and microstructure of an already existing Ti(N,C,O) coating by subjecting it to annealing in a low-temperature nitrogen-hydrogen plasma during the final stage of the process of its synthesis.

By combining the glow discharge assisted nitriding with the PACVD process in a single treatment with the use of a reactive atmosphere composed of tetraisopropoxytitanium vapours + hydrogen + nitrogen we can produce composite layers of the nitrided + Ti(N,C,O) type. The final annealing of the as-formed composite layers in a nitrogen+hydrogen atmosphere under glow discharge conditions decreases the oxygen content in the Ti(N,C,O) coating (Fig. 1) and reduces its surface roughness, thereby improving the performance properties of the composite layer (Fig. 2).

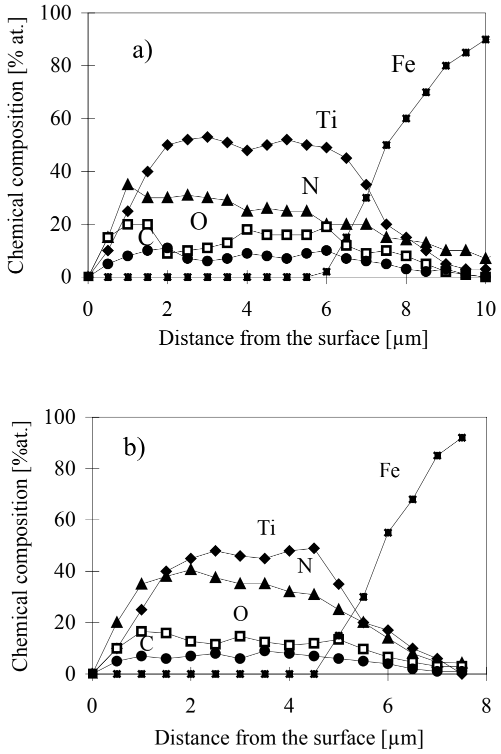

Fig.1. Chemical composition of the Ti(N,C,O) layer formed on nitrided Armco iron without the final annealing (a) and after final annealing in a $H_2 + N_2$ plasma (b)

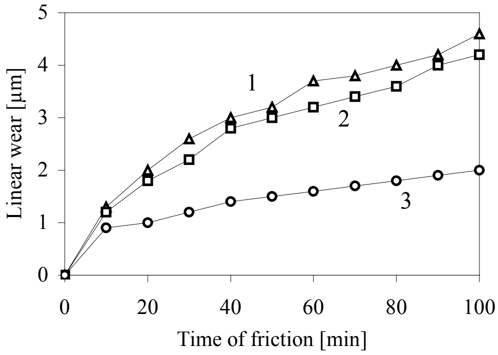

Fig.2. Linear wear of the surface layers of a Ti(N,C,O) coating(1), a composite layer of the nitrided Ti(N,C,O) type (2) and a composite layer subjected to final annealing (3) as a function of the friction time under a unit load of 200 MPa.

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