Study and characterization of thermodiffusion vanadium carbide on tool steels applied to plastic deformation and cutting of metallic materials

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Hard coatings of carbides on steel have been industrially used in innumerable applications. Research has been done to increase the process efficiency in the metallurgical, aerospace and oil exploration. This paper deals with the experimental study of the formation of hard vanadium carbide coatings (VC) on steel substrates by thermo reactive diffusion process (TRD). The TRD process is relatively simple and utilizes low-cost equipment and forming coatings with high hardness - from 3200-3800 HV [1] - resistance to wear, chemical and mechanical. These coatings are non-porous layers with thickness between 0.3 and 5 µm. The VC-TD process consists in the mixture of powders ($Na_2B_4O_7.10H_2O$ + V_2O_5 + B_4C) placed in a melting pot with the substrate and the process is heated at temperatures between 850 ° C to 1050 ° C [2]. The AISI D2, D6, H13 and O1 steels were selected due to the chemical composition to use as substrate. The VC-TD layer was characterized by scanning electron microscopy (SEM-EDS), X-ray diffraction and scratching. The SEM images showed that the vanadium carbide interface was found to be consistent for all samples and that the elements present in the substrate, in particular iron - undesirable in diamond film deposition CVD processes - were contained in the substrate itself. The EDS spectrum presents a variation in the vanadium carbide structure, obtaining V_8C_7, V_6C_5 and V_4C_3. It was observed that the differences in the carbon and chromium concentration interfere in the VC morphology. The VC layer deposited had characteristics that stand out over other carbides interfaces such as high adhesion, high hardness and high mechanical performance. The thermodiffusion VC layer can be used both in the final coating in tools for plastic deformation of metals and as an intermediate layer for the deposition of CVD diamond films on steel, due to its coefficient of thermal expansion around $6{,}06x10^{-6}K^{-1}$ [3] intermediate between diamond coefficients HFCVD and steel [1].