Characterization of Transition Metal Carbide Layers Synthesized by Thermo-reactive Diffusion Processes

Hard wear resistant surface layers of transition metal carbides can be produced by thermo-reactive diffusion processes where interstitial elements from a steel substrate together with external sources of transition metals (Ti, V, Cr etc.) form hard carbide and/or nitride layers at the steel surface. In this study halide-activated pack cementation techniques were used on tool steel Vanadis 6 and martensitic stainless steel AISI 420 in order to produce hard layers of titanium carbide (TiC), vanadium carbide (V8C7) and chromium carbides (Cr23C6 and Cr7C3). Surface layers were characterized by scanning electron microscopy, X-ray diffraction and Vickers hardness testing. The study shows that porosity-free, homogenous and very hard surface layers can be produced by thermo-reactive diffusion processes. The carbon availability of the substrate influences thickness of obtained layers, as Vanadis 6 tool steel produces thicker layers than AISI 420. X-ray diffraction analysis validates the formation of TiC and V8C7 layers on titanized and vanadized samples respectively, while chromized samples form both Cr23C6 and Cr7C3. It is shown that the two-phase layer of Cr23Cr6/Cr7C3 produced on Vanadis 6 can be transformed into a layer much richer in Cr7C3 and poorer in Cr23C6 by a subsequent heat treatment. The produced chromium-, vanadium- and titanium carbide layers have hardness values of 2116±37HV, 3022±119HV and 3951±66HV respectively, and subsequent hardening and tempering of treated materials can be done without spallation of the hard layers.