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The vanadium carbide deposition by thermodiffusion process for CVD diamond applications

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Diamond high-performance cutting tools have been studied over the last two decades. The CVD technique has undergone great technological advances, improving deposition efficiency, quality, crystallinity, and homogeneity. For it to be possible to grow CVD diamond on ferrous substrates it is necessary to have an intermediate layer able to act as an efficient diffusional barrier to avoid the transition metal´s migration to the CVD reaction zone, which may catalyze graphitic bonds formation. This barrier also blocks the carbon diffusivity from the gas phase which prevents the loss of material mechanical properties leaving it very hard and brittle. In addition, the intermediate material must have the ability to attenuate the compressive residual stresses after cooling. The vanadium carbide (VC) is a hardcover with elevated mechanicals properties (2600-3200HV) and it has an intermediate coefficient thermal expansion (CTE) (6.06x10-6K^{-1}) between diamond (0.8x10-6K^{-1}) and steel (11.6x10-6K^{-1}) CTE mismatch. In this work, we had two objectives: first, to deposit a VC layer over on AISI O1, AISI D6, AISI M2 and 1045 carbon steel by 3h of thermodiffusion reactive deposition (TRD); and second, to grow a high quality HFCVD diamond film on top of the VC coating at high temperatures. The results showed that the alloy elements impacted mainly the carbon supply at steel surface were TRD deposition occurs and it could change the vanadium carbide phase preponderance, thickness and morphology depending on alloy elements composition, proportion, and distribution on the substrate surface and cross-section. The HFCVD films were grown using the following conditions: 2sscm of CH_4; 98sccm of H_2; 2h deposition process time; 750°C and 5mm of work distance. The results of VC coating and HFCVD film characterizations were obtained by X-ray diffraction, scanning electron microscope field emission (SEM-FEG) and Raman spectroscopy.

Biography

Djoille Denner Damm is finishing his doctorate in materials engineering at the age of 32 years from São Paulo Federal University. He works as a researcher at the National Institute for Space Research. He has published 8 papers in reputed journals about CVD diamond deposition over carbon steels.

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