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From the development to the final application of W-containing DLC nanocomposite coatings

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Abstract – Maximum 100 words.

The association of high hardness with low friction coefficient makes DLC an excellent alternative for machining applications. However, the DLC "world" is so vast that a huge range of materials properties can be found for the coatings which can determine their successful or completely unsuccessful performance in practical applications. On the other hand, it is well known that machining of steel with C-based coatings is rather difficult due to the easy diffusion of C into the working part.

The aim of this study was to develop a suitable C-based coating for machining aluminum alloy parts. The focus will be placed on the influence of the addition of W and H on the structural, mechanical and tribological properties. The coatings were deposited in a 4-cathodes unbalanced magnetron sputtering equipment attached with: 1 Ti target for deposition of an adhesion interlayer; 1 C target embedded with W pellets and 2 pure C targets. By playing with the power applied to each cathode, in non-reactive or reactive modes, deposition of H-free or H-containing coatings with different W contents could be achieved.

Films with W and H contents from 0 to 12 at.% and from 0 to 40 at.%, respectively, were deposited. All coatings had an amorphous structure, although vestiges of crystallinity could be detected for the highest W contents. The addition of W led to a significant hardening of the DLC coating (from ~10 to 18 GPa); inversely, with H incorporation the hardness drop down to values even lower than that of pure DLC films. It was possible to establish a good correlation between the hardness and the residual stresses. In spite of the significant changes in the tribological performance when alloying DLC with W (decreasing of friction and wear coefficients) almost no difference was found among the W-DLC films whatever the W content was. A similar trend was achieved with the H addition. However, in this case a decrease in the friction coefficient was registered whereas the wear rate increased. The best performance concerning the friction was obtained for a H-containing coating (0.05) whereas, for the wear resistance, H-free W-DLC films were better performing (0.3×10^{-16} $m^3.N^{-1}.m^{-1}$).

After optimization, films with (~20 at.%) and without H and W contents close to 10 at.%, were selected for the in-service drilling tests which are currently being performed.