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The dependence of the structure and mechanical properties of thin ta-C coatings deposited using electromagnetic Venetian blind plasma filter on their thickness

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Abstract

In this paper, we present the results of studies determining the optimum thickness of amorphous tetrahedral carbon (ta-C) thin films for industrial applications. ta-C coatings from 50 to 1000 nm thickness were synthesized by a pulsed vacuum-arc method using a water-cooled electromagnetic Venetian blind plasma filter. Systematic studies of the thickness dependence of the microstructure and mechanical properties showed that the content of sp³ bonds in all the deposited coatings are equal (about 68%), but the 300 nm thick coatings exhibited the best mechanical properties (hardness $H > 50$ GPa, adhesion $L_{c2} = 48$ N). These coatings were deposited on industrial cutting taps with 2 and 2.5 mm diameters and tested in industrial conditions. The results of the threading tests performed with Inox stainless steel showed that the durability of the ta-C coated tools were significantly higher compared with the uncoated ones. These real-world industrial tests confirmed the usefulness of the electromagnetic Venetian blind plasma filter for synthesizing thin ta-C coatings with excellent physico-mechanical characteristics.

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