

Application of Taguchi Grey Analysis to Optimization of Mechanical Properties of ZrWN/buffer Multilayer Coatings

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Zirconium tungsten nitride (ZrWN) films are deposited onto SUS 304 stainless steel and glass, with and without a tungsten (W) and tungsten nitride (WN) buffer layer, by means of direct current (DC) reactive magnetron sputtering. This study determines the optimal parameter settings for the multilayer (ZrWN/buffer) deposition process using the Taguchi method for the design of a robust experiment and grey relational analysis. An orthogonal array, the signal-to-noise ratio and an analysis of variance are used to determine the effect of the deposition parameters. The main deposition parameters for the buffer layer, such as the W DC power, the substrate bias, the N₂/(N₂+Ar) flow rate, the substrate temperature, are optimized, with reference to the structure, morphological and mechanical properties of the multilayer (ZrWN/buffer) coating. The results show that the buffer layer improves the performance of ZrWN films. The N₂/(N₂+Ar) flow rate and the W DC power have the most significant effect on the mechanical performance. A Taguchi grey analysis shows that the coefficient of friction is reduced from 0.55 to 0.52, the corrosion potential increases from −0.18 to −0.16 V and the Vickers hardness increases from 13.44 to 17.65 GPa. The multilayer coatings exhibit no cracking or peeling-off, are homogeneous and highly dense and have a smooth surface and a very compact structure. They adhere well to the substrate and the indentation samples are classified as HF1.

Keywords: buffer layer; sputtering; Taguchi grey; mechanical properties.

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