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Effect of aluminum content on ion nitriding and nitriding kinetics of new SDAH13 extrusion die steel

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This study investigates the ion nitriding process of a novel aluminium-extruded mould steel (SDAH13 steel) with four different aluminium contents (0.01 wt.%, 0.21 wt.%, 0.76 wt.%, and 1.33 wt.%) through orthogonal and univariate experiments. Optical microscopy, scanning electron microscopy (SEM), and X-ray diffraction (XRD) were employed to characterise the microstructure and phase composition of the nitrided layer's cross-section. A microhardness tester was used to measure the hardness gradient across the nitrided layer, while Rockwell hardness tests examined the brittleness of the samples post-nitriding. The findings indicate that the optimal ion nitriding parameters are a nitriding temperature of 540℃, an holding time of 14 hours, and a furnace pressure of 400 Pa, with the most effective aluminium content being 0.76 wt.%. Under these conditions, the nitrided layer depth reached 270–290 μm, with a white layer thickness of 4–5 μm and a surface hardness of 1150 HV0.2.

Based on the ion nitriding results, the diffusion behaviour of reactive nitrogen atoms in SDAH13 steel with varying aluminium content was investigated, and the activation energy for the diffusion of reactive nitrogen atoms in this steel was calculated. Subsequently, mathematical expressions were proposed to predict the nitrided layer depth for SDAH13 steel with different aluminium contents at varying ion nitriding temperatures. Using Fick's second law and the Arrhenius equation alongside linear fitting methods, mathematical expressions were derived for the nitrided layer thickness in H11 steel (0.01 wt.% Al) and SDAH13 steel with 0.76 wt.% Al concerning holding time. Additionally, a relationship was established for the nitrided layer depth of these two compositions in relation to nitriding time and temperature.

Speaker Country

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