

KINETICS OF BORIDE LAYER GROWTH ON HIGH-CARBON STEEL

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The development of functional surface layers with superior mechanical, technological, and application-specific properties represents a critical objective in modern materials engineering. This necessitates the continuous optimization of existing surface engineering processes and the formulation of advanced treatment methods to enhance the operational performance of metallic substrates, particularly in terms of wear resistance and thermal stability [1].

Thermochemical treatment (TCT) remains one of the most effective methodologies for modifying surface characteristics through the formation of protective compound layers. Among TCT techniques, boronizing has emerged as a particularly promising process, involving the diffusion of boron into the steel surface to form hard boride phases. These boride layers are distinguished by their exceptional hardness, thermal stability, and resistance to abrasive and adhesive wear [2, 3].

This study systematically examines the effect of boronizing parameters on the growth kinetics of boride layers in U8 high-carbon steel. Metallographic and mechanical evaluations were performed on specimens subjected to diffusion boronizing under varying thermal and temporal regimes.

The experimental protocol comprised pack boronizing of U8 steel in a muffle furnace at process temperatures of 850, 900, and 950 °C with exposure durations of 4, 6, and 8 hours. A powder-based boronizing medium was employed to facilitate boron diffusion into the substrate [4].

Microstructural analysis revealed a tripartite morphology consisting of an outer FeB/Fe₂B boride layer, an underlying diffusion zone, and the core matrix. The boride layer exhibited a sawtooth interface profile, whose depth and intensity were found to be highly sensitive to boronizing conditions.

Quantitative measurements indicated that both increasing temperature and prolonging treatment time contributed to significant thickening of the boride layer. Temperature was identified as the primary kinetic driver, exerting the most pronounced influence on boron penetration depth, with higher thermal inputs yielding over a twofold increase in layer thickness.

Reference:

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