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Investigating Pack Boriding as a Surface Treatment for WC-Co Cold Forming Die Materials

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Abstract : Tungsten carbide-cobalt (WC-Co) is a widely utilized material for cold forming dies, including those employed in fastener production. In this study, we investigated the effectiveness of the pack boriding method in improving the surface properties of WC-Co cold forging dies. The boriding process involved embedding WC-Co samples, along with a steel control sample, within a chamber made of H13 tool steel. A boriding powder mixture was introduced into the chamber, which was then sealed using a paste. Subsequently, the samples were subjected to a temperature of 700°C for 5 hours in a furnace. Microstructural analysis, including cross-sectional examination and scanning electron microscopy (SEM), confirmed successful boron diffusion and its presence on the surface of the borided samples. The microhardness of the borided layer was significantly increased (3980 HV1) compared to the unborided sample (1320 HV3), indicating enhanced hardness. The borided layer exhibited an acceptable thickness of 45 microns, with a diffusion coefficient of 1.125 × 10-7 mm^2/s, signifying a moderate diffusion rate. Energy-dispersive X-ray spectroscopy (EDS) mapping revealed an increase in boron content, desirable for the intended purpose, while an undesired increase in oxygen content was observed. Furthermore, the pin-on-disk wear test demonstrated a reduction in friction coefficient, indicating improved mechanical and tribological properties of the surface. The successful implementation of the pack boriding process highlights its potential for enhancing the performance of WC-Co cold forging dies.

Keywords : WC-Co, cold forging dies, pack boriding, surface hardness, wear resistance, microhardness, diffusion coefficient, scanning electron microscopy, energy-dispersive X-ray spectroscopy
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