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Surface hardening and wear resistance of cemented carbides shock processed by high-intensity pulsed ion beam

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Ion beam shock processing (IBSP) of WC based cemented carbides was performed by using high-intensity pulsed ion beam irradiation at a power density of 10^7-10^8 W/cm^2. The coupled thermal and dynamic effects induced by the irradiation resulted in formation of a dense, binderless, remelted top layer of a few μm and a shock strengthened deep underlayer down to a hundred μm. Surface hardening of different degree was achieved by adjusting ion current density and shot number, and the hardening degree can be correlated to a series of microstructural changes involving phase transformation, selective ablation of binder phase and remelting densification. In contrast to the linear relations between wear resistance and hardness of bulk WC based cemented carbides reported in the literatures, an exponential rising trend of wear resistance on the surface hardness was found for the IBSP processed cemented carbides. As compared to conventional hardening factors of lowering the binder content or decreasing the WC grain size, the hardening by the IBSP process resulted not only from lowering binder content, but also remelting densification and shock strengthened binder phase where micro-defects healing, enhancement of bonding strength between WC grain and binder, and binder phase strengthening substantially changed the wear behaviors. The different mechanisms of hardening accounted for the nonlinear rising of wear resistance.

Keywords
High-intensity pulsed ion beam
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