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High-intensity pulsed ion beam technology for surface modification of cemented carbides

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High-intensity pulsed ion beam (HIPIB) technology is investigated for materials surface modification based on significant thermal-dynamic effects originating from the temporally and spatially compressed high heat input, delivered by the ion implantation of short pulse duration from tens to hundreds nanoseconds into a depth of material from submicron to micron scale under an ion kinetic energy typically of a few hundreds keV. Particularly, improvement in wear performance of WC-based cemented carbides is concerned by employing a HIPIB with ion kinetic energy of 300 keV and ion current density of 100-300 A/cm^2 up to 10 shots, producing a power density of 10^7-10^8 W/cm^2 and an energy fluence of 1-10 J/cm^2 per shot. The HIPIB irradiation induced notable surface remelting and selective ablation of metal binder, resulting in the formation of a dense, remelted layer of less binder phase with wavy surface topography. The morphologies, phase structure and microhardness of the HIPIB-irradiated cemented carbides were characterized along with numerical analysis of temperature and stress fields under HIPIB irradiation. The improvement in wear performance of HIPIB surface modified cemented carbides is discussed and understood in correlation to the surface features and characteristics produced by the HIPIB technology.

Keywords
High-intensity pulsed ion beam
Irradiation
Phase transformation
Tungsten carbide
Wear