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Experimental investigation on in-situ laser assisted diamond cutting nitriding mold steel

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Mold steel is widely adapted in precision molding for the massive manufacturing optical lenses due to excellent mechanical properties and corrosion resistance. Single point diamond cutting is a high effective technology for machining high freedom surface and sophisticated functional mirco/nanostructure. However, there is a challenge that the active chemical affinity between the diamond tool and mold steel which result in deteriorated surface integrity and catastrophic tool wear. In this research, we proposed a novel hybrid machining technology, which is in-situ laser assisted diamond cutting (In-situ LADC), for ultra-precision machining nitriding mold steel. Pulsed plasma nitriding treatment generates a dense nitriding compounds layer in workpiece surface to avoid chemical reaction with diamond tool. Meanwhile, the in-situ laser radiates and softens surface nitriding layer to improve the machinability of workpiece. Experimental results showed that the laser thermal effect obviously decreased the hardness and elastic modulus of nitriding layer, which enhanced the material removing in ductile mode. Compared with the ordinary cutting (OC), the machined surface roughness Sa is decreased from 64 nm into 12 nm. The maximum profile error PV is also decreased from 161 nm to 29 nm. The mechanism of tool wear was changed from the rapidly abrasive wear to mildly adhesive wear, which significantly increased working life by 29%.