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Abstract

The performances of the cutting fluids have recently been under investigation to drive machining operations towards cleaner and more sustainable targets. Several efforts are being made to test new formulations of coolants and to implement cooling strategies alternative to standard flooding. Cryogenic cooling seems to be an efficient solution to enhance the process sustainability when machining difficult-to-cut metals, such as nickel, cobalt and titanium alloys. Among its several advantages, no contaminants are left on the chips and workpieces, hence reducing the chips disposal costs and limiting skin and breath diseases for the machine tool operators. Furthermore, in case of production of surgical prostheses, it can help reducing the cleaning steps before the final sterilization.

The present work investigates the feasibility of using dry cutting and cryogenic cooling in semi-finishing turning of the Ti6Al4V titanium alloy produced by the Additive Manufacturing technology known as Electron Beam Melting when compared to standard flood cooling. For this purpose, the effects of the cutting speed and feed rate on the tool wear, surface integrity, and chip morphology were investigated as a function of the applied cooling strategy. The experimental findings show that the cryogenic cooling assures better performances than dry and wet machining by reducing the tool wear, improving the surface finish and the chip breakability, whereas dry cutting provokes more surface defects and severe tool wear. Therefore, from an environmental point of view, cryogenic machining can represent a sustainable process for manufacturing surgical prostheses made of AM titanium alloys.
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