# Abstract

Ti6Al4V alloy is one of the highly consumed engineering materials in the aerospace and automotive industries. The difficulty in the machining of Ti6Al4V alloy has driven the researchers in a continuous quest to find suitable machining strategies. With the rising interest of industries to embrace the sustainable manufacturing philosophy, the focus has been shifted to dry and near dry machining. This doctoral thesis has attempted the study in the direction of dry and near dry turning of Ti6Al4V alloy. The explored methods combine the laser surface texturing of cutting tools, hard coating deposition on cutting tools, and advance cutting fluid supply techniques.

In the first part of the study, the effect of texture shapes, depth, and area density on cutting forces and stress concentration have been studied using FE simulations. The influence of machining parameters on tool-chip contact length has been investigated for textured tools. In experimental studies, a nanosecond laser (solid-state Nd: YAG source) has been used for texturing the rake face of WC/Co cutting tools. A novel texture shape has been developed and coated with AlTiN and AlCrN coatings using a cathodic arc evaporation technique. The study established the influence of texturing and coating on the machining performance indicators (cutting forces, flank wear, chip flow direction, chip curling radius, etc.) during dry turning. Improved machinability for coated textured cutting tools has been achieved in terms of lower cutting forces, flank wear, and chip curling radius. A new concept of interfacial multi-point microcutting (IMP-μC) has been proposed during turning with textured cutting tools.

The presence of microscopic textures on cutting tool rake face complicates the understanding of tribological interaction between tool and chip material (at the secondary cutting zone). In order to disentangle the complex tool-chip tribological interaction, the tribo-tests have been performed.

Conventional close tribometer and novel open tribometer configurations have been utilized for evaluating the apparent coefficient of friction and wear mechanisms. Textured and AlCrN coated WC/Co surfaces resulted in excellent friction and wear reduction compared to other WC/Co surfaces. Experimental evidence confirmed the existence of the IMP-µC zone irrespective of the loading conditions and tribo-test configurations.

In the last part of the study, MQL and nMQL methods have been integrated as the cooling mediums with laser textured cutting tools. Sunflower oil in water and water suspended alumina nanofluids have been used for near dry turning at various cutting parameters. The best machining performance (lower cutting forces, friction coefficient, contact length, flank wear, etc.) has been achieved by integrating the MQL method with textured cutting tools. The experimental studies performed in the thesis can be regarded as a contribution to the steps towards the manufacturing of textured cutting tools in the near future.

**Keywords:** Titanium machining; Textured tools; Laser texturing; Sustainable machining