Investigation of machinability of polymer/nanoparticles nanocomposites

Abstract

With the development of composite materials, adding a small amount of nanoparticles to the polymer matrix material can significantly change the material properties and machining performance of the matrix. The improvement of these properties provides new application scenarios for the material. To ensure the smooth progress of future applications, research on the machining process of materials is indispensable.

Micromachining also complicates the material removal process because it differs from conventional machining in terms of cutting-edge radius, minimum uncut chip thickness (MUCT), and microstructure commonly referred to as size effect. There are three major challenges in studying the micromachining methods of nanocomposites, which are also the main significance of the experimental part of this research. They are the effect of cutting parameters on surface roughness, the effect of particles on surface roughness, and the effect of particles on material removal mechanism.

The effects of various weight fractions of graphene nanoplatelets (GNP) nanoparticles on the machining performance, including surface morphology, burr formation, cutting force and specific cutting energy, and tool wear are studied. And the size effect in the micromachining process was evaluated. The cutting process is invenstigated through both experimental and modelling approaches. The finite element method (FEM) cutting simulation models are established using polymer as the matrix material. The simulation results and the experimental results are compared and verified. The cutting force, tool-particles interaction, nanoparticle fracture behaviours, stress/strain distribution, chip formation process and surface morphology are investigated.