ME Seminar

Investigation of Tribological Effects on the Dynamic Stability in High-Speed Micromilling of Ti-6Al-4V

Dr. Rinku Kumar Mittal
DST INSPIRE Faculty Fellow

ABSTRACT

The micromilling process finds applications in biomedical, defence, electronics and aerospace industries for the fabrication of complex 3-D features and components. It may be noted that for difficult-to-cut materials like Ti alloys, limited stiffness of the micro-tool is a major obstacle. One way to address this issue is to use high rotational speeds which results in reduced chip loads and, therefore, the cutting forces. However, high spindle speeds and low tool stiffness make it susceptible to dynamic instability due to a variation in the cutting forces. High-speed micromilling of Ti-6Al-4V generates high temperature in cutting zone due to low thermal conductivity of Ti alloys which can also lead to a variation in cutting force and, hence, dynamic instability. Note that the friction and temperature variation during machining affects the cutting forces, which in turn can influence the dynamic stability of the system. This increase in the temperature accelerates diffusive wear resulting in a variation in the cutting forces. Note that the tool wear will not only affect the edge radius and the cutting forces, but also the stability limits. The cutting fluids and anti-abrasion/anti-friction coatings play an important role because of their capacity to reduce friction and dissipate the heat generated between the micro-tools and the workpiece. The effect of these tribological conditions: lubrication, coatings and wear, on dynamic stability in high-speed micromilling process has been investigated. In addition, the gyroscopic couples induced by high rotational speeds can also affect the stability limits in high-speed micromilling. Hence, a higher order multiple degrees of freedom (MDOF) stability model based on rotor dynamics has been developed to capture the effect of gyroscopic couple in high-speed micromilling.

ABOUT THE SPEAKER

Dr. Rinku Kumar Mittal is a DST INSPIRE Faculty fellow. He obtained his B-Tech, M-Tech and PhD degrees from the Indian Institute of Technology, Bombay. As part of his PhD work, Dr. Mittal carried out experimental and modelling investigations of tribology and chatter stability in high-speed micromilling of Ti-6Al-4V. He has worked on systems integration and development of a high-speed micromachining center which has been commercialized and supplied to IIT Bhilai and BITS Pilani. Dr. Mittal's research has resulted in 9 international peer reviewed journal publications and 2 US patents.

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