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Acoustic Emission for Tool-Chip Interface Monitoring during Orthogonal Cutting

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Abstract : The measurement of the interface conditions in a cutting tool contact is essential information for performance monitoring and control. This interface provides the path for the heat flux to the cutting tool. This elevate in the cutting tool temperature leads to motivate the mechanism of tool wear, thus affect the life of the cutting tool and the productivity. This zone is representative by the tool-chip interface. Therefore, understanding and monitoring this interface is considered an important issue in machining. In this paper, an acoustic emission (AE) technique was used to find the correlation between AE parameters and the tool-chip interface. For this reason, a response surface design (RSD) has been used to analyse and optimize the machining parameters. The experiment design was based on the face centered, central composite design (CCD) in the Minitab environment. According to this design, a series of orthogonal cutting experiments for different cutting conditions were conducted on a Triumph 2500 lathe machine to study the sensitivity of the acoustic emission (AE) signal to change in tool-chip contact length. The cutting parameters investigated were the cutting speed, depth of cut, and feed and the experiments were performed for 6082-T6 aluminium tube. All the orthogonal cutting experiments were conducted unlubricated. The tool-chip contact area was investigated using a scanning electron microscope (SEM). The results obtained in this paper indicate that there is a strong dependence of the root mean square (RMS) on the cutting speed, where the RMS increases with increasing the cutting speed. A dependence on the tool-chip contact length has been also observed. However there was no effect observed of changing the cutting depth and feed on the RMS. These dependencies have been clarified in terms of the strain and temperature in the primary and secondary shear zones, also the tool-chip sticking and sliding phenomenon and the effect of these mechanical variables on dislocation activity at high strain rates. In conclusion, the acoustic emission technique has the potential to monitor in situ the tool-chip interface in turning and consequently could indicate the approaching end of life of a cutting tool.

Keywords : Acoustic emission, tool-chip interface, orthogonal cutting, monitoring
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