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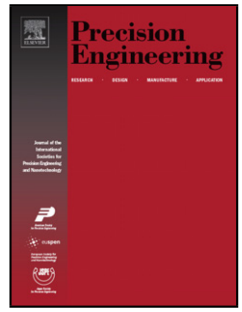

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Minimum Chip Thickness Determination by means of Cutting Force Signal in Micro Endmilling

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Highlights

1. Determination of minimum chip thickness by means of cutting forces from dynamometer;
2. Determination of efficient sampling frequency in micomilling process;
3. Describe micromilling process dynamics on the periodicity of the cutting forces signal;
4. Characterization of the effect of cutting edge radius upon cutting forces during chip formation and;
5. Modelling of ploughing process by means of cutting force signal.

Abstract

Issues related to ploughing affecting the performance of the micromilling process have recently been reported in literature. It is well known that there is a minimum chip thickness (h_{min}) below which ploughing is the main material removal mechanism and no shear occurs. This leads to a non-effective material removal, resulting in a poor surface quality. In order to solve this problem, the minimum chip thickness has been predicted by measuring the cutting forces. However, the determination of h_{min} by means of the cutting force signal, at the instant the chip is being formed, has not been approached. In this article, a method of determining h_{min}, based upon the signal variation of the cutting forces and the effect of tool radial runout during chip formation is proposed. Carbide micro-endmills without coating were used to cut an aluminium alloy (RSA 6061-T6) sample and the cutting forces were measured using a micro-dynamometer. The microtopography of a microchannel wall was assessed using an optical profiler in order to establish the approximate position where the chip starts to form (h_{min}). As the cut progresses, the force component normal to the feed (F_{fN}) reverses when the undeformed chip thickness is equal to the cutting edge radius (r_e). Simultaneously, the thrust force increases rapidly, and continues to grow but at a lower rate as F_{fN} increase. The main cutting force and the active force present significant differences to each other. The minimum chip thickness was estimated as $0.3r_e$ by means of the behavior of the active force. A small quantity of material left on the wall of the microchannel could be observed in align with the cutting movement together with a deterioration of the surface finish attributed to the increase of r_e. Results show that the size of the material left is 2 to 4 times greater than h_{min}. Conversely, the quality of the microchannel floor improves as r_e increase. This shows that there is a balance between h_{min} and r_e and the effect upon the finish of the channel wall and floor. That should be important for microchannel fabrication in terms of performance of micro-

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