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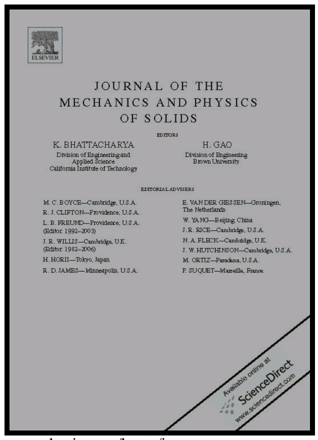

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Wei Ma, Xiangyu Chen, Fei Shuang

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The Chip-Flow Behaviors and Formation Mechanisms in the Orthogonal Cutting Process of Ti6Al4V Alloy

Wei Ma*, Xiangyu Chen, and Fei Shuang

Institute of Mechanics, Chinese Academy of Sciences, Beijing 100190, China

Abstract

This work involves experimental and analytical investigations of chip flow stability in metal cutting process. First, in cutting experiments of Ti6Al4V alloy, the transformation of chip morphology from continuous to serrated and later to discontinuous was observed as the cutting speed increased. Scanning electron microscopic (SEM) observation of the shear fracture surface demonstrated shear-localized instability and intergranular failure behaviors. Then we used the improved orthogonal cutting model (OCM) to analyze the plastic flow process of work materials in a plane strain state. A corresponding governing equation system was set up, the dimensionless governing parameters were determined by dimensional analysis, and an instability criterion was established by linear perturbation analysis. Analytical results showed that the plastic instability of chip flow could take place in a continuous chip, which is different from the shear-localized instability in a serrated chip. Finally, in terms of the balance conditions between the kinetic energy and the surface energy, the sawtooth growth behavior in serrated chips and the formation mechanism of discontinuous chips were studied.

1. Introduction

The high-speed machining (HSM) process plays a crucial role in the rapidly developing manufacturing industry. Due to the nonlinear and dynamic nature of the process, technological improvement and processing optimization require a better understanding of its physical essence. Generally, the process involves plastic instability, rate sensitivity, friction heating, material softening and convection. For such a complex process, a great number of accomplishments have

* Corresponding author, email: watwm@imech.ac.cn