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Numerical and experimental investigations of particle embedment during the incubation period in the solid particle erosion of ductile materials

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Abstract

During solid particle erosion, a transient incubation period can occur due in part to particle embedment into the target. This paper presents a novel three-dimensional smoothed particle hydrodynamics model of the impact and embedding of successive bursts of 362 μm angular SiC abrasives onto a 6061-T6 aluminum target. The predicted embedment agreed well with measured values from abrasive blasting experiments. Approximately 20% of the particles launched in the first two bursts embedded, but as incoming particles removed previously embedded ones, embedment decreased to a steady-state 8% after 6 bursts. The model has applications for predicting the embedment occurring during abrasive jet machining using multiple nozzle passes, and sheds light on embedment mechanisms during the incubation period of solid particle erosion.

Keywords: particle embedment, incubation period, solid particle erosion, smoothed particle hydrodynamics

1.0 Introduction

Solid particle erosion occurs when a target material is removed due to successive impingement of solid particles [1-3]. While it is mostly considered as a serious problem in engineering systems, solid particle erosion is also employed in abrasive jet micro-machining (AJM) applications as a tool for fabrication. When high-speed particles impact ductile targets, a proportion of them often remain embedded. Embedment is viewed as an unwanted phenomenon in AJM, since it can decrease the erosion rate by shielding the surface [4, 5], decrease the efficiency in micro-heat exchanger applications [6], and enhance the surface roughness thereby changing the flow in microfluidic applications [7, 8].

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