Society of Engineering Science 51st Annual Technical Meeting 1–

3 October 2014

Purdue University, West Lafayette, Indiana, USA

Damage evolution assessment and modeling for CBN grinding wheel wear

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ABSTRACT

The wear rate of a grinding wheel directly affects the workpiece surface integrity and tolerances. This paper summarizes a combined experimental-modeling framework for life expectancy of an electroplated Cubic Boron Nitride (CBN) grinding wheel, typically utilized in nickel-based superalloy grinding. The article presents an experimental framework to facilitate the formulation of a micromechanics based modeling framework. The presented study investigates the topological evolution of the grinding wheel surface and mechanisms of grit failure via depth profiling, digital microscopy, and scanning electron microscopy. The results are used to elucidate the statistical evolution of the grinding wheel surface. Different modes of grit failure, including grit attritious wear, fracture, and pull out haven been identified. The analysis of the surface topological features indicates a unique grit activation process, leading to a nonuniform spatial distribution of the grit wear. In addition, single grit pull out experiment has been conducted to assess the residual strength of the grit–wheel interface and the associated state of damage percolation. The experimental results are utilized in developing a life expectancy model for the CBN grinding wheel to assess the grit mean time to failure as well as grit surface topological evolution as a function of the process parameters.