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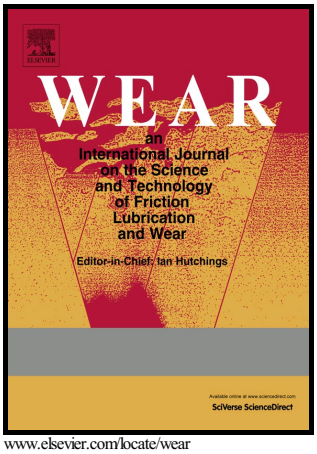

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Numerical and Experimental Analysis of Particle Fracture during Solid Particle Erosion, Part I: Modeling and Experimental Verification

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Abstract

Most previous models of solid particle erosion have assumed the abrasives to be rigid, as opposed to deforming, and have largely ignored the effect of particle fracture and fragmentation. However, since particle fracture dissipates kinetic energy and may lead to secondary impact, it can affect the resulting erosion rate and associated mechanisms. In this paper, double pulsed laser shadowgraphy was used in order to record, for the first time, the impact, fracture, and rebound of 363 μm SiC abrasive particles in a high speed air jet impacting an Al6061-T6 plate at incident velocities between 78 and 123 *m/s*. The impact and fracture of the abrasives was simulated using an Element Free Galerkin (EFG) formulation with a Johnson-Holmquist material model for the SiC particles, and smoothed particle hydrodynamics with a Johnson-Cook material model for the target. A new technique was developed to generate the CAD representation of the actual abrasive particle geometries directly from shadowgraphic measurements of the particles in flight. The numerical simulations and experimental observations revealed that : (i) the distribution of the predicted and measured rebound particle velocities were in reasonable agreement; (ii) the measured and predicted ratio of the average rebound to incident velocity were 0.34 and 0.36, respectively (9.5% difference); (iii) the geometries of the simulated and measured particle fragments matched well, i.e. the average predicted and measured circular diameters were 156 μm and 157.5 μm, respectively, and the measured and predicted roundnesses were 0.54 and 0.59. Overall, the study shows that particle fracture and fragmentation can be predicted reasonably well using such numerical techniques. The accompanying paper further verifies the model and uses it to examine the effect of process parameters on particle fragmentation.

Keywords: Particle fracture, Solid particle erosion, Shadowgraphy, Element Free Galerkin (EFG), Johnson-Holmquist

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