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Finite Element Modeling of Two-Phase Microstructure during Metal Cutting

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Abstract : This paper presents a novel approach to modelling the metal cutting of duplex stainless steels, a two-phase alloy regarded as a difficult-to-machine material. Calculation and control of shear strain and stresses during cutting are essential to achievement of ideal cutting conditions. Too low or too high leads to higher required cutting force or excessive heat generation causing premature tool wear failure. A 2D finite element cutting model was created based on electron backscatter diffraction (EBSD) data imagery of duplex microstructure. A mesh was generated using 'object-oriented' software OOF2 version V2.1.11, converting microstructural images to quadrilateral elements. A virtual workpiece was created on ABAQUS modelling software where a rigid body toolpiece advanced towards workpiece simulating chip formation, generating serrated edge chip formation cutting. Model results found calculated stress strain contour plots correlated well with similar finite element models tied with austenite stainless steel alloys. Virtual chip form profile is also similar compared experimental frozen machining chip samples. The output model data provides new insight description of strain behavior of two phase material on how it transitions from workpiece into the chip.

Keywords : Duplex stainless steel, ABAQUS, OOF2, Chip formation
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