

Comparison of the Machining Behavior of Additively Manufactured IN 625 and Cast Wrought IN 625

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Additive manufacturing has recently gained momentum as new technologies have made possible three-dimensional (3D) printing of functional parts; especially in the aerospace sector, where intricate parts fabricated from superalloys are demanded. The strength of the additive materials may be larger than the strength of conventional counterparts. Ductility and resistance to fracture tend to be lower in additive materials compared to conventional materials. Furthermore, surface finish and dimensional accuracy are difficult to control directly from 3D printing. For these reasons, hybrid-processing involving finishing by machining are required; but the behavior of the additive materials during machining is not known. This research aims at closing this knowledge gap by initiating comparisons between the machining behavior of additively manufactured (AM) and cast-wrought (CW) superalloy IN 625. An experimental study of the velocity field that develops within the primary shear zone (PSZ), and the resulting machining force and chip morphology has been carried out to compare the machinability of these two materials. An ultra-high speed imaging system was used to capture 8 sequential images at a frame rate of 200 KHz. The velocity field was obtained by digital image correlation (DIC). Forces were recorded using a piezoelectric dynamometer. Chips were observed by 3D profilometry. While differences in forces were not resolvable, there were substantial differences in strain rate and chip morphology. The strain rate from AM IN 625 was lower than that from CW IN 625. In the case of CW IN 625 full serration across the width of the chips indicated adiabatic shear banding. In the case of AM IN 625, partial the serration patterns indicated that material failure was still operative, but it did not result from adiabatic shear banding. The implications of these mechanistic effects are being correlated to economically relevant outputs such as machine tool vibrations, and tool temperature and wear.