World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:17, No:09, 2023

Investigating the Viability of Small-Scale Rapid Alloy Prototyping of Interstitial Free Steels

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Abstract : The defining property of Interstitial Free (IF) steels is formability, comprehensively measured using the Lankford coefficient (r-value) on uniaxial tensile test data. The contributing factors supporting this feature are grain size, orientation, and elemental additions. The processes that effectively modulate these factors are the casting procedure, hot rolling, and heat treatment. An existing methodology is well-practised in the steel Industry; however, large-scale production and experimentation consume significant proportions of time, money, and material. Introducing small-scale rapid alloy prototyping (RAP) as an alternative process would considerably reduce the drawbacks relative to standard practices. The aim is to finetune the existing fundamental procedures implemented in the industrial plant to adapt to the RAP route. IF material is remelted in the 80-gram coil induction melting (CIM) glovebox. To birth small grains, maximum deformation must be induced onto the cast material during the hot rolling process. The rolled strip must then satisfy the polycrystalline behaviour of the bulk material by displaying a resemblance in microstructure, hardness, and formability to that of the literature and actual plant steel. A successful outcome of this work is that small-scale RAP can achieve target compositions with similar microstructures and statistically consistent mechanical properties which complements and accelerates the development of novel steel grades.

Keywords : rapid alloy prototyping, plastic anisotropy, interstitial free, miniaturised tensile testing, formability
Conference Title : ICMMPME 2023 : International Conference on Mining, Mineral Processing and Metallurgical Engineering
Conference Location : Vancouver, Canada
Conference Dates : September 25-26, 2023