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An innovative method for the microstructural modification of TiAl alloy solidified via direct electric current application

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Abstract:

Ti-48Al-2Cr-2Nb alloy solidified with the application of direct electric current has a refined and homogeneous microstructure without segregation. We observed an initial decrease followed by a subsequent increase in grain size and lamellar spacing, with the increase in current density. Similar trend can also be obtained by varying the amount of α_2-phase (Ti_3Al). Using a directional solidification processing method, the columnar crystal microstructure transforms into an equiaxed crystal microstructure at a current density of 32~64 mA/mm^2. High dislocation density is also introduced with a minimum cross-sectional grain size of 460 μm at a current density of 64 mA/mm^2. The application of electric current alters the free energy of the critical nucleus and temperature via joule heating, causing a transformation from a columnar grain microstructure into into an equiaxed grain microstructure. The increase in current density leads to a rise of the nucleation rate, and a resulting undercooling combined with temperature gradient contribute to growth of the primary phase, which finally results in grain coarsening at a critical current density of 96 mA/mm^2. The climb and cross-slip of dislocation and the migration of grain boundary

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