

Research progress on magnetic ultrafine grain/homogenization melting and casting technology for high-performance copper alloys

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Abstract: This study addresses the challenges in metallurgically preparing high-strength, high-conductivity, and high-elasticity copper and copper alloys. Leveraging the unique multi-mode non-contact force/energy effects of electromagnetic fields, we apply key multi-scale effects-including electromagnetic separation/purification, stirring/oscillation, and thermoelectric magnetic currents/forces-to their fabrication. During continuous casting, these electromagnetic interventions promote the refinement of grains, dendrites, and precipitates within the solidification microstructure, alongside enhanced compositional homogeneity. This approach enables the production of high-performance master alloy ingot characterized by exceptional cleanliness/purity, ultrafine grains, and high uniformity. These advanced copper materials hold significant potential for applications in aerospace, 5G communications, and new energy sectors, contributing to energy conservation, circular economy practices, and the advancement of carbon peaking and carbon neutrality goals.

Keywords: Magnetic solidification; Ultrafine grain; Homogenization; High-strength, high conductivity, and high elasticity copper alloy.

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