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Thermoelectric magnetohydrodynamic effects in solidification processes

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ABSTRACT

Applying an external magnetic field to pure metals and alloys has been shown to have a profound effect during solidification. The underlying mechanism is due to convective transport from Thermoelectric Magnetohydrodynamics (TEMHD). The driving Lorentz force is generated through the interaction of thermoelectric currents and the magnetic field. This phenomenon has been observed or inferred in a wide range of solidification processes including directional solidification and high undercooled growth. More generally, this effect can be substantial in any solidification process that exhibits large thermal gradients. This paper discusses the effect of TEMHD in modifying microstructure evolution in processes such as directional solidification and how TEMHD affects the tip velocity during high undercooled growth. In the former case, the magnetic field has the potential to introduce an additional control system to many material processes, while in the latter case, the application of a magnetic field may have implications for fundamental solidification experiments.

KEYWORDS: thermoelectrics, magnetic field, solidification