The Change of Solidification Parameters on Hypoeutectic Aluminum–Silicon Alloy Under Different Cooling Rates

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ABSTRACT

Computer-aided cooling curve analysis (CA-CCA) is a cost-saving and easy-to-use thermal analysis tool to identify the solidification characteristics of a material. This paper aims to present the relationship between cooling rate and solidification parameters of aluminum–silicon alloy before semisolid metal processing. An induction furnace was used to melt the as-prepared specimen by heating the respective graphite crucible to 680 °C and left it to be cooled and solidified under three different cooling rate conditions. A double thermocouple method was employed by placing one K-type thermocouple at the crucible center and another one near to the crucible wall. Both thermocouple sensors were connected to a data acquisition device, NI 9219 which was linked to a computer with DASYLab pre-installed inside for data logging, along with OriginPro 2019b for graphical representation. Low, intermediate, and high cooling rate conditions were achieved when the crucible was cooled with its top and bottom surface enclosed with Fiberfrax felt (1.0 °C/s), at ambient temperature (1.3 °C/s), and by a compressed air flow supplied from air compressor (1.9 °C/s), respectively. The increase in cooling rate facilitates the nucleation rate and the growth of crystals within the alloy system and thus leads to a shorter solidification time with all the critical points highlighting the phase transition are shifted accordingly.

KEYWORDS: CA-CCA, Cooling rate, Aluminum–silicon alloy, Solidification parameters

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REFERENCES

[1] ASM International Handbook Committee, ASM handbook volume 2: properties and selection—nonferrous alloys and special-purpose materials

[2] Kaufman JG, Rooy EL (2004) Aluminum alloy castings: properties, processes, and applications. https://doi.org/10.1017/CBO9781107415324.004

[3] Nafisi S, Ghomashchi R (2016) Semi-solid processing of aluminum alloys. Springer International Publishing, Cham. https://doi.org/10.1007/978-3-319-40335-9

[4] Spencer DB, Mehrabian R, Flemings MC (1972) Rheological behavior of Sn-15 pct Pb in the crystallization range. Metall Trans 3(7):1925–1932. https://doi.org/10.1007/BF02642580