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Measurement of Thermophysical Properties for Developing Thermal Storage Materials Using Miscibility Gap Alloys

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1. Introduction

Thermal energy storage is an essential technology for stabilizing the fluctuating electricity supplies generated from renewable energy sources[1]. Phase Change Materials (PCMs), which store energy through latent heat, hold great promise for the development of reliable thermal energy storage systems because of their stable operation temperature[2]. Metallic PCMs are particularly suitable candidates due to their high energy density at melting temperature and high thermal conductivity to achieve high energy exchange efficiency[3]. Although operating at higher temperatures is desirable to enhance system efficiency, chemical reactions of the PCMs with contact materials arises as crucial problem at elevated temperature. To address this challenge, Miscibility Gap Alloys (MGAs) are expected to prevent chemical reactions by encapsulating the low-melting-point phase with a phase that is stable at high temperatures[4].

To design the microstructure and evaluate the capacity of Miscibility Gap Alloys as thermal storage materials, understanding the thermophysical properties of the alloys in the molten state is indispensable. We have embarked on a project aimed at measuring the thermophysical properties of liquid alloys in miscibility gap systems utilizing the International Space Station (ISS). The thermophysical properties, such as density, surface tension, and viscosity, were measured using the Electrostatic Levitation Furnace (ELF), which has been installed in the Kibo module of the ISS. The obtained thermophysical properties were evaluated based on uncertainty analysis and compared with the data measured under gravity. Using these thermophysical properties, the heat and mass transport phenomena were evaluated through numerical simulations. The latest progress of the project will be presented.

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