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Zinc-rich eutectic alloys for high energy density latent heat storage applications

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Abstract

The interest on latent heat storage (LHS) materials has experienced a remarkable increase during last years. The main advantage of PCM materials is their higher energy density compared to sensible materials one. In this article the synthesis process and structural and thermophysical characterization of $Zn_{84}Al_{8.7}Mg_{7.3}$, $Zn_{88.7}Al_{11.3}$ and $Zn_{92.2}Mg_{7.8}$ (at.%) eutectic metallic alloys have been performed in order to evaluate their potentiality as PCMs for LHS applications. Their correct synthesis process has been proved by the structural study and their melting/solidification temperatures, heat of fusion, specific heat and thermal conductivity have been investigated. The results show melting temperatures of 344 °C, 382 °C and 371 °C and heat of fusion of around 132 J g^{-1}, 118 J g^{-1} and 106 J g^{-1} for $Zn_{84}Al_{8.7}Mg_{7.3}$, $Zn_{88.7}Al_{11.3}$ and $Zn_{92.2}Mg_{7.8}$, respectively. The obtained energy densities for the investigated alloys are almost two times higher than the ones for similar metallic PCM reported in literature. On the other hand, the measured thermal conductivities are ranging in the solid state from 66 to 139 W m^{-1} K^{-1} and in the liquid state, from 33 to 58 W m^{-1} K^{-1}, which represent the main advantage of these PCM candidates when are compared to the most studied ones such as the inorganic salts. The proposed storage materials can be a highly suitable solution in TES applications when compact system, high power levels and very fast thermal responses are required.

Keywords

Thermal energy storage; Eutectic metallic alloys; Phase change material (PCM); Latent heat storage; Structural characterization; Thermophysical properties

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