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Effect of indium addition on mechanical, thermal, and soldering properties of eutectic Sn–9Zn alloy

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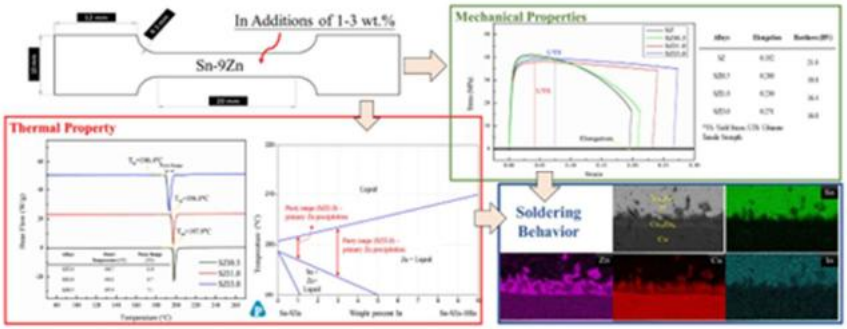
HIGHLIGHTS

- Improved Elongation in Eutectic Sn–9Zn through In Additions.
- Highest Elongation of Sn–9Zn by Coarsened Spacing of Zn Phase with 3.0 wt% In.
- Reinforcement of Sn–9Zn with Solid Solution of 3.0 wt%.
- Supporting Discussions with Calculations from the Sn–Zn–In Phase Diagram.
- Improved Wetting Behavior and Soldering Temperature of Sn–9Zn with 3.0 wt% In Addition.

GRAPHICAL ABSTRACT



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ABSTRACT

This study aims to enhance the properties of eutectic Sn–9Zn (SZ) alloys as a replacement for low-melting Sn–Pb alloys by adding 0.5–3.0 wt% In, forming SZ–In (SZI) alloys (referred to as SZIx, where *x* indicates the In content in wt.%). The elongation of 19.2 % for SZ improved to 27.1 % for the SZI3.0 owing to the addition of soft In and enlarged Zn phase. SZI3.0 exhibited a higher strength (39.2 MPa) than SZI1.0 (35.5 MPa) because of the stronger reinforcement with increasing In content in the solid solutions. Moreover, SZI3.0 had a lower melting temperature (190 °C) compared to SZ (199.5 °C), thereby enhancing its soldering wettability on Cu. A reliable SZI3.0/Cu joint was achieved at a lower reflow temperature of 230 °C without a protected atmosphere. These findings revealed the promising mechanical (strength and ductility), thermal (low melting temperature), and soldering (wettability) performance of SZI3.0.

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現職：逢甲大學 材料科學與工程學系 副教授

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沈育安博士現任逢甲大學材料科學與工程學系副教授，研究領域涵蓋低熔點合金、半導體封裝技術與金屬界面反應。其研究主要聚焦於低溫製程用接合材料之設計、機械性質與可靠度，並探討其界面反應、微結構變化與熱處理行為，相關成果可應用於先進封裝、柔性電子與異質整合封裝等領域。

沈教授至今已發表約 60 篇學術期刊論文，H-index 為 24，並於 2025 年入選全球前 2% 科學家名單。近年研究成果亦陸續獲得肯定，包括中國工程師學會工程論文獎，以及本次中國材料科學學會材料科學論文獎。

在學生培育方面，沈教授亦指導專題生獲得 114 年度國科會大專學生研究創作獎。

此次獲得材料科學論文獎，對沈教授與研究團隊而言是很大的鼓勵。沈教授感謝材料學會的肯定、逢甲大學材料系、學生、合作夥伴以及家人的支持。未來將持續在材料科學研究及人才培育上盡一份心力。