

Komitet za termodinamiku i fazne dijagrame Srbije
u saradnji sa:

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Tehničkim fakultetom u Boru i
Associated Phase Diagram and Thermodynamics Committee
(Poland, Czech Republic, Hungary, Bulgaria, Slovenia, Serbia,
Montenegro, Romania, Croatia, Bosnia and Herzegovina)

**DVANAESTI SIMPOZIJUM O TERMODINAMICI
I FAZNIM DIJAGRAMIMA**
sa međunarodnim učešćem



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Wetting behavior of Sn-Bi solder alloy and composites obtained by powder metallurgy

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Abstract

This study examined the wetting behavior of solders composed of tin-bismuth (Sn-Bi) alloys and their composites. To produce the SnBi12 (wt. %) alloy, pure powders of tin (Sn) and bismuth (Bi) were used. After that, the composites were produced by adding 0.2 wt.% of graphite (C) and boron carbide (B₄C) to the SnBi₁₂ alloy. The alloys and composites were fabricated using a powder metallurgy technique. Initially, the powders were weighed in specific ratios to create the SnBi12 matrix powder. After this, 0.2 wt.% of C and B₄C were added to the matrix powder. The mixing was done using a three-axis mixer at a speed of 50 rpm for 4 hours. The mixed powders were then mechanically stirred in a ball mill at a speed of 150 rpm for 2 hours. Following this, the powders were compacted with a hydraulic press, and the samples were sintered in an inert argon atmosphere at a temperature of 185 °C for 3 hours. For the wetting behavior investigation, the copper plates were polished and cleaned in acetone. Small samples weighing 0.1 grams were taken from the sintered samples and placed on copper plates along with 0.02 grams of flux RMA218. These copper plates were then heated to 250 °C for 20 seconds to initiate the soldering. After cooling, the solders were cleaned with acetone, photographed, and cut to examine their cross-sections under an optical microscope. The contact angle and spreading area were measured using ImageJ software. The results indicate that the pure tin sample exhibited the highest wetting angle. The addition of bismuth to form the tin-bismuth alloy reduced the wetting angle by approximately 20%. Furthermore, when reinforcements of carbon (C) and boron carbide (B₄C) were added, the wetting angles increased slightly but remained lower than that of the pure tin sample. The surface area values mirrored the trends observed in the wetting angles: as the wetting angles decreased, the surface areas increased, and vice versa.

Type of work: original research paper.

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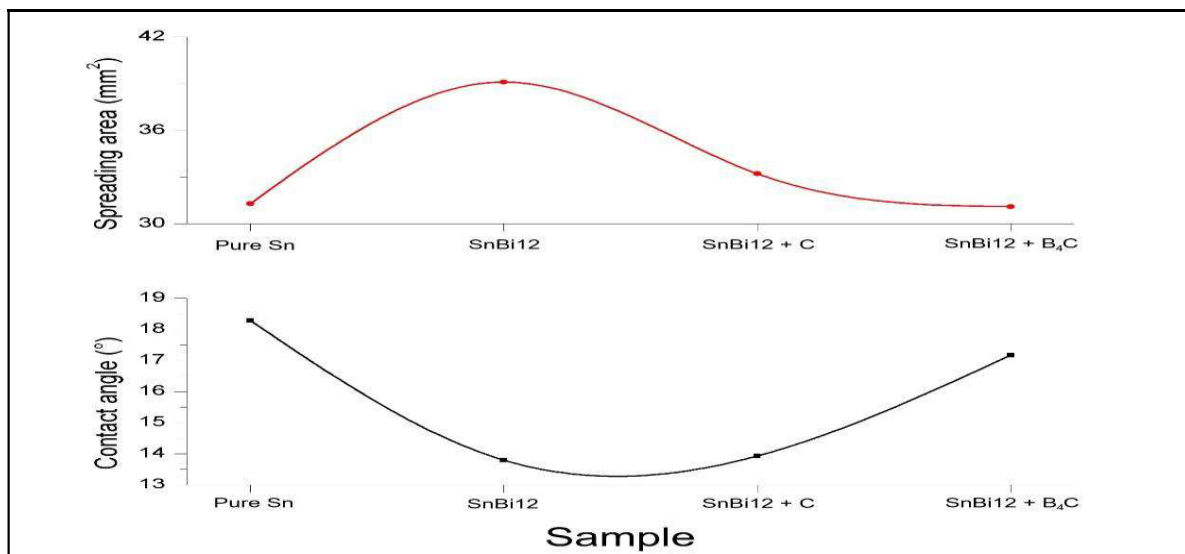
References

1. Y.A. Shen, The Journal of The Minerals, Metals & Materials Society, 75 (2023) 4922-4930.
2. F. Wang, H. Chen, Y. Huang, L. Liu, Z. Zhang, Journal of Materials Science: Materials in Electronics, 30 (2019) 3222–3243.
3. N. Fathy, K.M. Hafez, F. Abdulaziz, R.E. Abdelraouf, M. Ramadan, Scientific Reports, 15 (2025) 6849.

Graphical abstract:



Cured samples prepared for the contact angle measurement.



The wetting behavior of the investigated samples.



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