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Data Article

Microstructure and chemical data of the thermoelectric ZnSb material after joining to metallic electrodes and heat treatment

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Abstract

The data presented in this article are related to the research article entitled: "Solder free joining as a highly effective method for making contact between thermoelectric materials and metallic electrodes" (S. A. Malik, L. T. Hung, N. V. Nong, 2017) [1]. This article presents microstructure obtained by scanning electron microscopy (SEM) and chemical analysis by energy dispersive X-ray spectroscopy (EDX) point measurements of the thermoelectric ZnSb legs after joining to metallic electrodes using solder (Zn-2Al) and free-soldering methods.

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Specifications Table

Subject area	*Material Science*
More specific subject area	*Thermoelectric Energy Conversion*
Type of data	*Table, Image (microscopy)*
How data was acquired	*SEM/EDX analysis*
Data format	*Raw, Analyzed*
Experimental factors	*The ZnSb legs prepared by Spark Plasma Sintering technique from reaction of elemental commercial powders. The surfaces of the leg were polished and cleaned before joining.*
Experimental features	*The quality of material after joining with metallic electrodes was examined.*
Data source location	*Technical University of Denmark, Risø Campus, 4000 Roskilde, Denmark.*
Data accessibility	*The data presented in this article are accessible within this article.*

Value of the data

- **This data elaborates the importance of solder free joining method for making good contacts in thermoelectric devices.**
- **The data presented in this article shows detailed microstructure and EDX analysis of ZnSb material after joining and heat treatment.**
- **This data allows other researchers to compare the conventional joining method with new solder-free joining method.**

Data

The following data provides information on the SEM images and EDX analysis along the thermoelectric ZnSb legs. The Figs. 1-3 show micrographs of the ZnSb legs after joining and heat treatment. Tables 1-3 present the concentration ratio of Zn:Sb at selected regions along the leg.

1. After conventional joining with solder:

Figure 1 presents a typical SEM micrograph of the ZnSb leg after conventional joining using Zn − 2Al solder alloy. The chemical analysis of selected EDX point measurements along the leg is presented in table 1. The average ratio of Zn:Sb is 56:44.

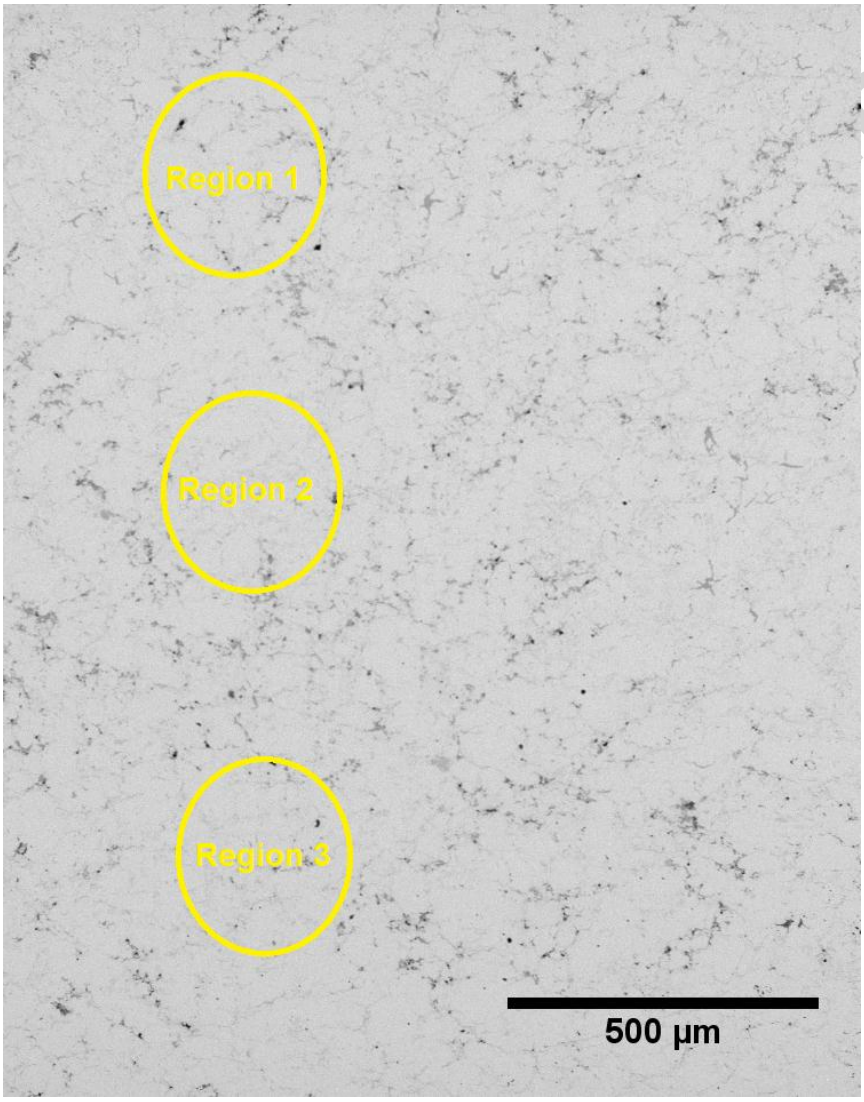

Figure 1: SEM micrograph and selected EDX point measurements of the ZnSb leg after joining to metallic electrodes using Zn − 2Al solder.

% Ratio	Region 1	Region 2	Region 3	Average
Zn:Sb	56.5:43.0	55.3:44.7	56.2:43.4	56:44

Table 1: Typical EDX point measurements along the ZnSb leg shown in figure 1.

2. After solder-free joining:

Figure 2 presents SEM micrographs of the ZnSb legs after solder-free joining with (a) Ti and (b) Cr as interconnecting agents. The EDX point measurements on selected regions are presented in table 2. The average Zn:Sb ratios are 48.5:51.5 for (a) and 50.8:49.2 for (b).

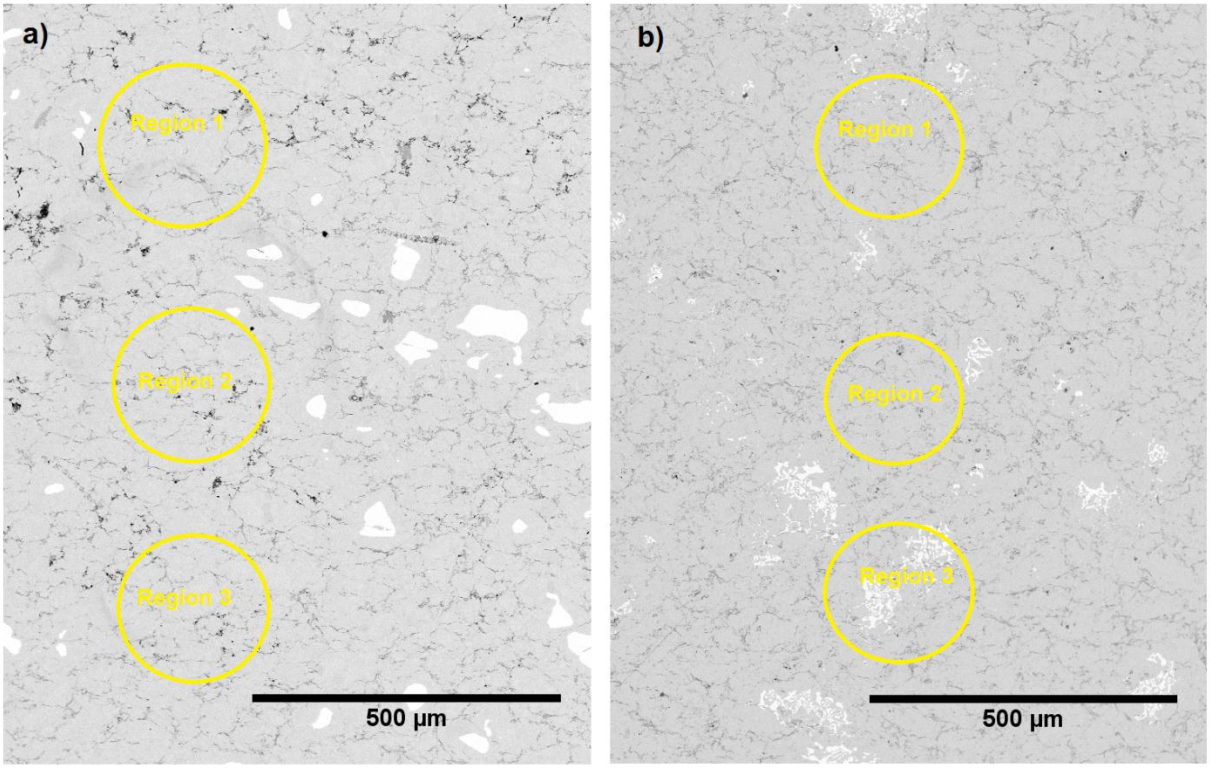

Figure 2: SEM micrograph and selected EDX point measurements along the ZnSb leg after solder-free joining to Ni electrode with (a) Ti and (b) Cr as interconnecting agents.

Table 2: Typical EDX point measurement along the ZnSb legs shown in figure 2.

% Ratio	Region 1	Region 2	Region 3	Average
(a) Zn:Sb	48.9:51.1	47.9:52.1	48.9:51.1	48.5:51.5
(b) Zn:Sb	49.8:50.2	50.5:49.5	52.3:47.7	50.8:49.2

Figure 3 shows SEM micrograph of the ZnSb leg after solder-free joining and heat treatment for 30 hours at 400 ^{o}C with (a) Ti and (b) Cr as interconnecting agents. The typical EDX point measurements are given in table 3.

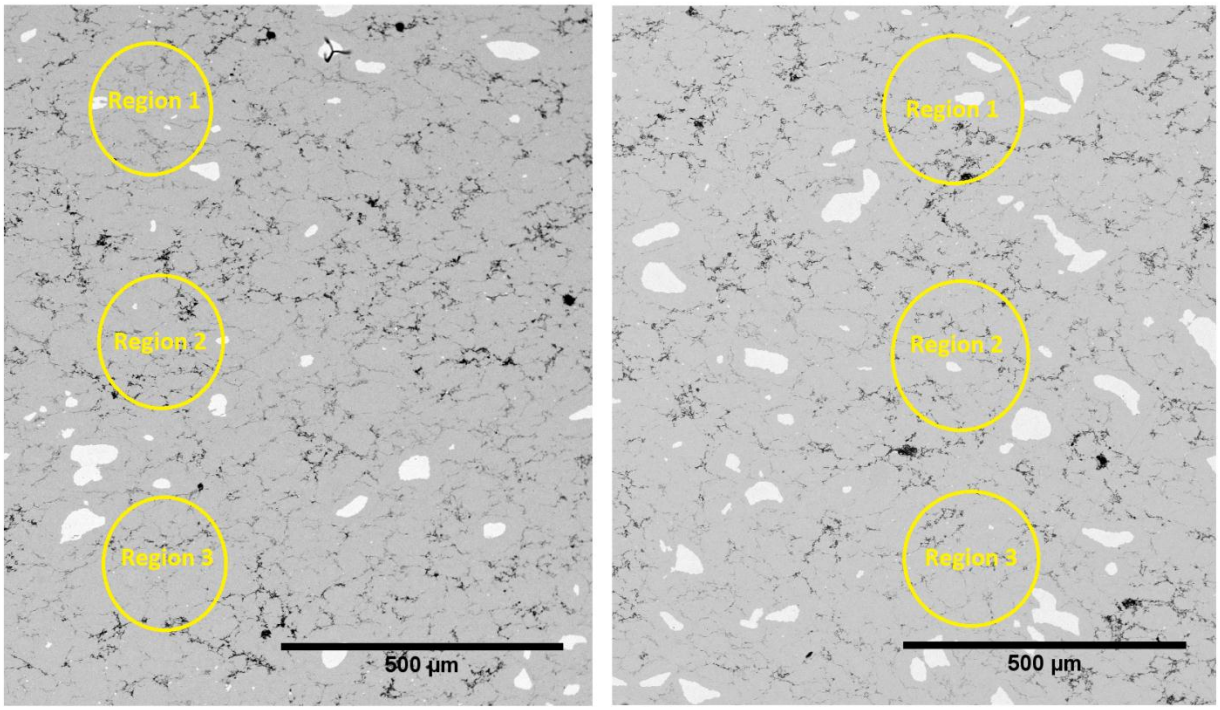

Figure 3: SEM micrograph of the ZnSb leg after solder-free joining and heat treatment for 30 hours at 400 ^{o}C with (a) Ti and (b) Cr as interconnecting agents.

Table 3: Typical EDX point measurement along the ZnSb legs shown in figure 3.

% Ratio	Region 1	Region 2	Region 3	Average
(a) Zn:Sb	50.9:49.4	50.8:49.2	51.4:48.6	~ 51:49
(b) Zn:Sb	50.1:49.9	51.9:48.1	51.5:48.5	~51:49

Experimental Design, Materials and Methods

ZnSb ingots used for this study were provided by TEGnology AS, Denmark. ZnSb legs with dimension of 3x3x3 mm^3 were cut to join with metallic electrodes (Ni, Ag) using two methods: the conventional with solder and a solder-free method [1]. The joining were performed in the temperature range of 400 ^oC – 450 ^oC under a pressure of 3 MPa for 30 min. Heat treatment of the joint parts was carried out at 450 ^oC for 30 h. The SEM images and EDX point measurements along the ZnSb leg after joining were carried out in a Hitachi TM3000 scanning electron microscope.

Acknowledgments

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References

1. S. A. Malik, L. T. Hung, N. V. Nong, “Solder free joining as a highly effective method for making contact between thermoelectric materials and metallic electrodes”, Materials Today Energy, Vol. 5, 2017, p. 305-311. DOI: 10.1016/j.mtener.2017.07.012.