Cu-ZnSb Interface in Thermoelectric Applications

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Motivation and Aim of Study

ZnSb has sufficient thermoelectric efficiency to be used in thermoelectric generators between 200 and 400°C. The choice of metallic interconnects is vital in ensuring long device life-time and in minimizing the efficiency loss. Heat-treated Cu-ZnSb samples will be studied primarily with transmission electron microscope to determine the stability of the interface.

Introduction

Thermoelectric (TE) materials such as ZnSb can generate electricity from a temperature difference which is done by thermoelectric generators (TEGs). The metallic interconnects between n- and p-type legs are important components. The ideal interconnect should have the following properties[1]:

- High electrical and thermal conductivity
- Remain stable in contact with TE material
- Low contact resistance
- Similar thermal expansion coefficient as TE material

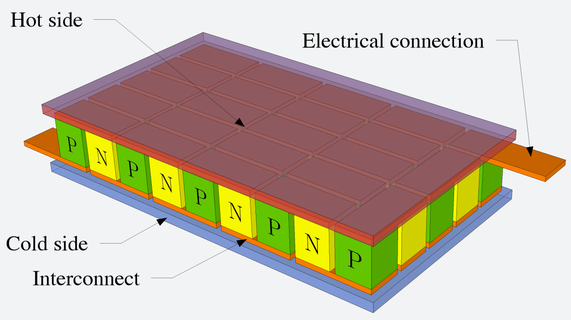
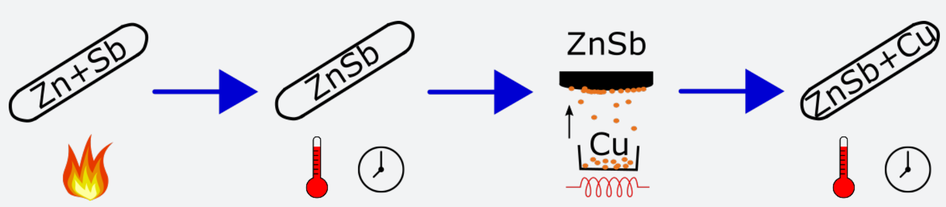


Figure 1: Design of a thermoelectric generator

Preparation of ZnSb Samples



- ZnSb made in evacuated quartz ampules followed by annealing at 490°C.
- Cu deposited by thermal evaporation.
- Heat-treated between 100 and 250°C.

Possible Evolution of Cu-ZnSb Interface

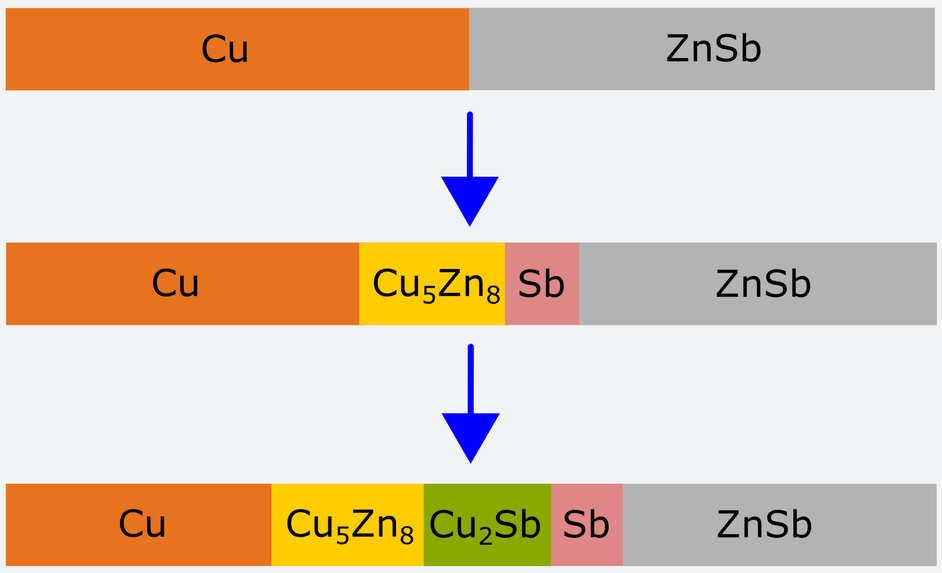


Figure 2: Cu is not in equilibrium with ZnSb making the appearance of new phases likely. This is exemplified here by the formation of several new phases at the interface.

Methods

- Transmission electron microscopy (TEM)
  - Selected area diffraction
  - Energy dispersive X-ray spectroscopy
  - Electron energy-loss spectroscopy
- X-ray diffraction

Material Identification by HRTEM

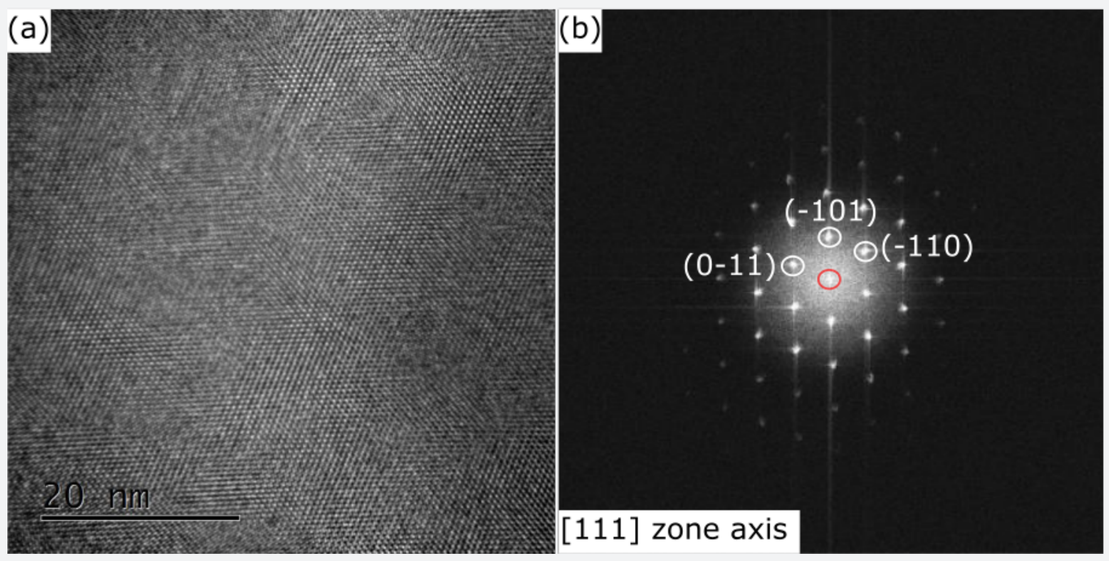


Figure 3: **a** HRTEM image of ZnSb. **b** Fast fourier transform image of **a**.

Metal-TE Interfaces Reported in Literature

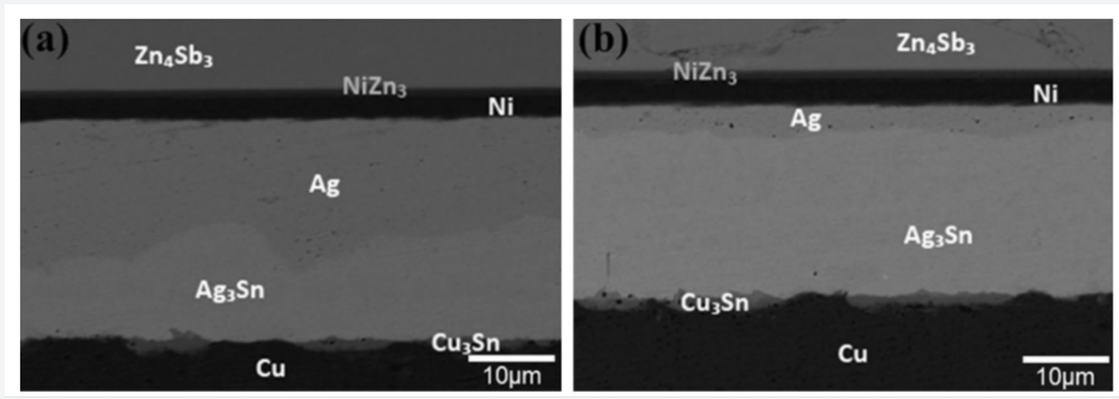


Figure 4: New phases are seen at the interface between Zn_4Sb_3 and several metals after a bonding process done at 250°C for **a** 5 min and **b** 10 min[2]. **c** The original interface before bonding.

References

[1] Dinesh K. Aswal, Ranita Basu, and Ajay Singh.
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[2] Y. C. Lin, K. T. Lee, J. D. Hwang, H. S. Chu, C. C. Hsu, S. C. Chen, and T. H. Chuang.
Solid Liquid Interdiffusion Bonding of Zn4Sb3 Thermoelectric Material with Cu Electrode.
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