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A study of thermoelectric $\beta$-Zn$_4$Sb$_3$ under thermal cycling and large temperature gradients

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$\beta$-Zn$_4$Sb$_3$ is among the highest performance and lowest cost thermoelectric (TE) materials in the medium to high temperature region [1]. However, the usage of this material in practice for TE power generation is still hindered. In this study, the thermoelectric properties of $\beta$-Zn$_4$Sb$_3$ legs are investigated under thermal cycling at hot-side temperatures up to 718 K, and in a large temperature difference of 653 K, corresponding to the hot and cold side temperatures of 673 K/293 K. The results after thermal cycling reveal that a $zT$ value of about 1.4 at 718 K is maintained after 30 cycles. However, under a temperature gradient of 653 K for 24 hours, the $\beta$-Zn$_4$Sb$_3$ leg gradually decomposes into zinc whiskers and ZnSb. This occurs in a temperature range lower than 563 K due to the nature of the phase transition [2]. This study provides insight into the stability of $\beta$-Zn$_4$Sb$_3$ under large temperature gradients.

Figure 86: SEM micrographs of $\beta$-Zn$_4$Sb$_3$ sample before and after 24 hours under temperature gradient of 653 K.

References: