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Electrodeposition of Bi_2Te_3 thin films for thermoelectric applications: effect of electrolyte pH

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ABSTRACT

Modern materials like Bi_2Te_3 nanostructures are one of the most promising thermoelectric materials since they show a high value of the thermoelectric figure of merit. This paper reports the effect of electrolyte pH (in a low pH range starting from 0.25 to 1.50) on the structural, electrochemical, and thermoelectric properties of the electrodeposited Bi_2Te_3 films. Two of the samples showed significantly high values of Seebeck coefficient (49.28 μV/T and 45.26 μV/T, respectively), which are comparable to the Si (42 μV/T), SiC nanowires (40 μV/T), and Ge (47 μV/T) thermoelectric materials. Also, the observed crystallinity and electrochemical behavior are in agreement with the thermoelectric results for electrodeposited Bi_2Te_3 films. In nutshell, a lower range of pH of electrolytes has been found to be a significant control parameter in the present study. Such Plausible tailoring of properties would be helpful for the systematic study of complex and multi-composite materials for various applications.

1 Introduction

There are many thermoelectric materials being studied in the form of thin films. Materials like Bismuth Chalcogenides [1], Lead tellurides [2, 3], Inorganic Clathrates [4, 5], Mg-B^{IV} compounds [6, 7], Homologous oxides [8, 9], Half-Heusler alloys [10, 11] etc.

Among these materials, in the current thread of research, Bi_2Te_3 has been studied extensively. This is due to its high value of thermoelectric figure of merit at room temperature. In addition, out of many methods of synthesis, electrodeposition method has been explored by the researchers. Electrodeposited Bi_2Te_3 nanowire arrays (12–33 μV/K), pulse electrodeposited Bi_2Te_3 thin films (− 65 μV/K), and *n*-type Bi_2Te_3 films (− 51.6 μV/K) had shown Seebeck coefficient ranging from 12 to 65 μV/K [12–14].

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