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Electrophoretic Deposition of p-Type Bi2Te3 for Thermoelectric Applications

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Abstract : Electrophoretic deposition (EPD) of p-type Bi₂Te₃ material has been accomplished, and a high quality crack-free thick film has been achieved for thermoelectric (TE) applications. TE generators (TEG) can convert waste heat into electricity, which can potentially solve global warming problems. However, TEG is expensive due to the high cost of materials, as well as the complex and expensive manufacturing process. EPD is a simple and cost-effective method which has been used recently for advanced applications. In EPD, when a DC electric field is applied to the charged powder particles suspended in a suspension, they are attracted and deposited on the substrate with the opposite charge. In this study, it has been shown that it is possible to prepare a TE film using the EPD method and potentially achieve high TE properties at low cost. The relationship between the deposition weight and the EPD-related process parameters, such as applied voltage and time, has been investigated and a linear dependence has been observed, which is in good agreement with the theoretical principles of EPD. A stable EPD suspension of p-type Bi₂Te₃ was prepared in a mixture of acetone-ethanol with triethanolamine as a stabilizer. To achieve a high quality homogenous film on a copper substrate, the optimum voltage and time of the EPD process was investigated. The morphology and microstructures of the green deposited films have been investigated using a scanning electron microscope (SEM). The green Bi₂Te₃ films have shown good adhesion to the substrate. In summary, this study has shown that not only EPD of p-type Bi₂Te₃ material is possible, but its thick film is of high quality for TE applications.

Keywords : electrical conductivity, electrophoretic deposition, mechanical property, p-type Bi2Te3, Seebeck coefficient, thermoelectric materials, thick films
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