

Towards a nanostructured thermoelectric generator using ion-track lithography

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This paper presents the process development towards a new generation of nanostructured thermoelectric generators for power harvesting from small temperature gradients by using a combination of traditional silicon microfabrication techniques, electroplating and submicron ion-track nanolithography. Polyimide nanotemplates with pore diameters ranging from 30 nm to 120 nm were fabricated. Preliminary results from the fabrication of poly(methyl methacrylate) (PMMA)-nanostructured templates are reported. Bi_2Te_3 nanowires (80 and 120 nm diameters) were electroplated into polyimide ion-track nanotemplates. Bi_2Te_3 nanowires of a R3 m structure, with preferential orientation in (1 1 0) crystallographic planes, were electroplated. The chemical composition of Bi_2Te_3 with nearly stoichiometric composition ($\text{Bi}_{2.31}\text{Te}_3$) was obtained. Homogeneity profiles of the chemical composition were obtained. A fine-grained observed microstructure (6–10 nm) and (1 1 0) crystalline orientation were obtained, which is extremely promising for improving the thermoelectric material properties. The thermoelectric properties of the Bi_2Te_3 -electroplated thin films (Seebeck coefficient α) and electrical resistivity of the Bi_2Te_3 bundle nanowires were found to be $-52 \mu\text{V K}^{-1}$ and $\sim 14 \text{ M}\Omega \text{ cm}$, respectively. Polyimide (Kapton foil) and PMMA 950 photoresists were promising materials for the realization of a nanostructured thermoelectric generator on flexible and rigid substrates, respectively.