World Academy of Science, Engineering and Technology
International Journal of Physical and Mathematical Sciences
Vol:13, No:06, 2019

Pyroelectric Effect on Thermoelectricity of AlInN/GaN Heterostructures

Authors : B. K. Sahoo

Abstract : Superior thermoelectric (TE) efficiency of $Al_xIn_{1-x}N$ /GaN heterostructure (HS) requires a minimum value of thermal conductivity (k). A smaller k would lead to even further increase of TE figure of merit (ZT). The built-in polarization (BIP) electric field of $Al_xIn_{1-x}N$ /GaN HS enhances S, and σ of the HS, however, the effect of BIP field on k of the HS has not been explored. Study of thermal conductivities (k: without BIP and kp: including BIP) vs temperature predicts pyroelectric behavior of HS. Both k and kp show crossover at a temperature Tp. The result shows that below Tp, kp < k due to negative thermal expansion coefficient (TEC). However, above Tp, kp > k. Above Tp, piezoelectric polarization dominates over spontaneous polarization due to positive TEC. This generates more lattice mismatch resulting in the significant contribution of BIP field to thermal conductivity. Thus, Tp can be considered as primary pyroelectric transition temperature of the material as above Tp thermal expansion takes place which is the reason for the secondary pyroelectric effect. It is found that below Tp, kp is decreased; thus enhancing TE efficiency. For x=0.1, 0.2 and 0.3; Tp are close to 200, 210 and 260 K, respectively. Thus, k of the HS can be modified as per requirement by tailoring the Al composition; making it suitable simultaneously for the design of high-temperature pyroelectric sensors and TE module for maximum power production.

Keywords : $Al_xIn_{1-x}N$/GaN heterostructure, built in polarization, pyroelectric behavior, thermoelectric efficiency
Conference Title : ICAAPMS 2019 : International Conference on Advances in Applied Physics and Materials Science
Conference Location : Venice, Italy
Conference Dates : June 20-21, 2019