Graphene Superlattice based Thermoelement for Radioisotope Thermoelectric Generator

Shakti Kumar Mishra[a,1], Avinash Pente[a], Amar Kumar[a], Chetan Prakash Kaushik[a, 1] and Biswaranjan Dikshit[b,1]

[a]Waste Management Division and [b]Laser and Plasma Technology Division
Bhabha Atomic Research Centre, Trombay, Mumbai, India 400085
[1]Homi Bhabha National Institute, Mumbai, India 400094
Tel Ph. No. -(+91) 9870086848, (+91) 022 2559 4624; shaktimishra15@gmail.com ; shakti@barc.gov.in

Abstract

In the present day's RTGs; major limitation is the lower conversion efficiency of segmented thermoelectric unicouple; which necessiates the development of technically suitable thermoelement with enhanced efficiency. The maximum conversion of thermal to electrical energy of the present day thermoelement is limited to 15 % only. This is attributed to its lower Seebeck coefficient and figure-of-merit. Graphene superlattice heterostructures based thermoelement is being studied to increase the conversion efficiencies significantly and seems to be promising candidate for replacement of the existing lower efficient thermoelement. This is possible by applying different electric potential on the top metallic gate electrodes periodically patterned over the h-BN encapsulated graphene superlattice which is deposited on a SiO_2 substrate backed by a doped Si substrate acting as a back gate. The maximum Seebeck coefficient can be tuned by varying the gate electrodes potential. Initially the gate voltage is supplied from an external source and later switched over to Seebeck potential after reaching a stable voltage range. Transfer matrix approach was followed for theoretical calculations of the Seebeck coefficient. This also describes the feasibility of graphene superlattice element based RTGs followed by evaluation of its overall efficiency under the similar conditions with respect to temperature & surface area of heat source. Due to higher efficiency, this gives the possibility for an alternative radioisotope like easily available radio nuclides Am-241 and Sr-90 as compared to Pu-238; which is used in today's RTGs. This can be achieved without compromising with the power output & payload.

Keywords: Graphene Superlattice Heterostructures, Radioisotope Thermoelectric Generator, Defect barrier, Segmented Thermoelectric Unicouple.