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GRAPHENE IN LAYERED NANOSTRUCTURES

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Graphene – 2D carbon allotrope – is a unique nanomaterial due too its physical properties: semiconductor with zero band gap, high electrical and thermal conductivity, high optical transparency and mechanical strength. Such properties open wide applications of graphene in many fields such as electronics, optoelectronics, thermoelectrics etc. Combination of graphene with other nanomaterials in layered nanostructures can provide creation of heterostructures with improved physical properties.
In this work the improvement of crystal structure and physical properties of nanomaterials combining them with graphene will be considered on graphene/Bi2Se3/graphene layered structures [1], graphene/ZnO nanolaminates [2], graphene/Bi2Se3/ZnO heterostructures [3]. The enhancement of properties is predicted from changes in crystal structure during synthesis of nanostructures on graphene substrates (graphene, ZnO and Bi2Se3 have similar lattice geometry allowing epitaxial growth onto graphene) and due to charge transfer at the interface of created layered structures. For the fabrication of layered structures chemically vapor deposited graphene was transferred onto supporting quartz substrates and for graphene/ZnO nanolaminates - onto ZnO nanostructures. ZnO nanostructured layers were synthesized using atomic layer deposition technique. Bi2Se3 nanostructured coatings were synthesized onto graphene using catalyst-free vapour-solid deposition technique. Morphology and crystal structure of fabricated heterostructures were studied using scanning electron microscopy, atomic force microscopy, X-ray diffractometry. Thermoelectric properties of Bi2Se3 in graphene/Bi2Se3/graphene layered structures were studied by electrical conductivity and thermoelectric measurements. Optical properties of ZnO in heterostructures were investigated by absorbance and photoluminescence measurements. Correlation between the structure, optical and thermoelectrical properties of semiconductor nanolayers in layered heterostructures is analyzed. Possible mechanisms of improving the optical and thermoelectric properties of graphene-containing layered nanostructures are proposed. Fabricated nanostructures showed the good potential for applications in thermoelectric and optoelectronic devices.

References:
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