Ultrathin diamond nanofilms as possible two-dimensional insulators for future nanoelectronics

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Hydrogenation of graphene [1] enlarges its potential application in nanoelectronics. Total hydrogenation of graphene changes the nature of electronic states due to changing of sp^2 hybridization of C-C bonds to sp^3 one and opens the dielectric band gap. Such two-dimensional insulator was called as graphane [2].

Graphane is only first member in a series of sp^3 bonded diamond films with nanometer thickness (or diamanes) consist of a number of adjusted $\langle 111 \rangle$ oriented layers which display unique physical properties [3]. The consequent study of graphene, graphane and proposed diamanes can be considered as bottom-up nanotechnological approach opposite to ordinary top-down paradigm. The main goal of this work is the theoretically study of diamane physical properties. We considered diamanes with different thickness; we investigated their stability and compared them with known data for sp^3-hybridized hydrocarbon clusters. We studied the elastic properties of the structures and obtained phonon dispersion (as well as Raman spectra), wave velocities and elastic constants of the films. We calculated phase diagram depended upon the diamond film thickness and discussed possible ways of synthesis of the considered structures and their application in nanoelectronics and nanooptics.

References

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Figures