Contribution ID: **92** Type: **Poster**

Features of the temperature dependences of the thermal conductivity of composites and the Meyer-Neldel rule

Tuesday, 24 September 2024 17:50 (5 minutes)

An analysis of the temperature dependences of thermal conductivity κ(T) of composite materials - graphene-multilayer graphene, semiconductor composites Bi0.5Sb1.5Te3 and In0.53Ga0.47As, was carried out as well as a comparison of their temperature dependences of κ(T) with the thermal conductivity of similar materials, which are formed by superlattices, nanowires and hybrid nanostructures. The temperature dependence of the thermal conductivity κ(T) of these materials can be presented as the sum of two contributions – quasi-particle κp and coherence contributions κc:
$= p + c$, (1)
which corresponds to two main mechanisms of heat transfer [1]. In the case of orientationally ordered crystals, thermal conductivity, as a rule, can be represented as:
$= AT - 1 + 0$, (2)
where the first term is determined by the three-phonon scattering processes of quasiparticles (phonons), and the second term is related to the wave properties of phonons and their ability to tunnel between phonon bands corresponding to the acoustic and optical phonon branches in the real dispersion law [1].
In the case where long-range order is present, the value of the coherent contribution κc is usually small compared to the quasi-particle contribution κp, but it becomes significant when no translation order - then it takes place the glass-like behavior of thermal conductivity – and it can be presented through an exponential dependence of the Arrhenius type:
$c = 0\ exp(-E/T)$ (3)
with two characteristic parameters: pre-exponential factor κ0 and energy E. It was shown that the temperature dependences of thermal conductivity with glassy behavior are quite well described by expression (3). Also, it is established that the pre-exponential factor κ0 depends linearly on the energy E. Such a relationship between these values was previously discovered in the electrical conductivity of semiconductors (Meyer-Neldel rule) [2, 3].

References:
[1] A.I. Krivchikov, Y.V. Horbatenko, O.A. Korolyuk, O.O. Romantsova, O.O. Kryvchikov, D. Szewczyk & A. Jezowski. Exponential approximation of the coherence contribution to the thermal conductivity of complex clathrate-type crystals. Materialia, 32, 101944 (2023).
[2] A.I. Krivchikov & O.A. Korolyuk. Empirical universal approach to describing the thermal conductivity of amorphous polymers: Effects of pressure, radiation and the Meyer–Neldel rule. Low Temperature Physics, 50(4), 328-341 (2024).
[3] W.V. Meyer and H. Neldel. Relation between the energy constant and the quantity constant in the conductivity–temperature formula of oxide semiconductors, Z. tech. Phys., 18(12): 588–593 (1937).

Primary author: Dr HORBATENKO, Yuliia (B.Verkin Institute for Low Temperature Physics and Engineering of the National Academy of Sciences of Ukraine)

Co-authors: Dr KOROLYUK, Oksana (B. Verkin Institute for Low Temperature Physics and Engineering of NAS of Ukraine); Prof. KRIVCHIKOV, Oleksander (B. Verkin Institute for Low Temperature Physics and Engineering of NAS of Ukraine); Dr ROMANTSOVA, Olesya (B. Verkin Institute for Low Temperature Physics and Engineering of NAS of Ukraine)

Presenter: Dr HORBATENKO, Yuliia (B.Verkin Institute for Low Temperature Physics and Engineering of the National Academy of Sciences of Ukraine)

Session Classification: Poster Session

Track Classification: CONDENSED MATTER PHYSICS