Some peculiarities of isotopic materials science

V.G. Plekhanov

Fonoriton Sci. Lab., Garon LtD., Lasnamae 22- 3, Tallinn, 11413, Estonia

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Over of last five decades a great number of stable isotopes and well – developed method of their separation has made it possible to date to grow crystals of C, LiH, ZnO, ZnSE, CuCl, GaN, GaAs, CdS, Cu_2O, Si, Ge, α-Sn as well as graphene with a controllable isotopic composition. The use of such objects allows the investigate of not only the isotope effects in diffusion and lattice dynamics (vibrational, elastic and thermal properties) but also the influence of such effects on the electronic states via electron – phonon coupling (the renormalization of the band – to – band transition energy E_g as well as the exciton binding energy E_b). The thermal conductivity enhancement in the isotopically enriched materials amounts (C, Ge, SI) to almost 10% at room temperature and is close to a factor of six at the thermal conductivity maximum around 20K (Si-case). The change in the lattice constant is $\Delta a/a \sim 10^{-3}$- 10^{-4}, while the change Δc_{ik} in the elastic constants amounts to several percent. Very pronounced and general effects of isotope substitution are observed in phonon spectra. The scattering lines in isotopically mixed crystals are not only shifted (the shift of LO lines exceeds 100 cm-1) but are also broadened. Capture the thermal neutrons by isotope nuclei followed by nuclei decay produces new elements in a very large number of possibilities for isotope selective doping of different materials. Although the technology of isotopic materials science is still in its infancy, it is necessary underline that it has a very wide applications: beginning from optical fiber technology still modern development in isotope information storage and isotope quantum computers.

Biography by V.G. Plekhanov (short sketch).

Professor Vladimir G. Plekhanov was graduated Tartu State University in 1968, Ph. D. (Physics and Mathematics, 1972), Doctor of Science (Physics and Mathematics, 1982). Main interest fields: the origin of the mass (quantization of matter) as well as isotopic materials science. He is author approximately 200 publications both in English and Russian. Main books: Isotope Effects in Solid State Physics (Academic Press, San Diego, 2001);Isotope - Based Quantum Information (Springer, Heidelberg, 2012); Isotopes in Condensed Matter (Springer, Heidelberg, 2013); introduction to Isotopic Materials Science (Springer, 2018, in press).

