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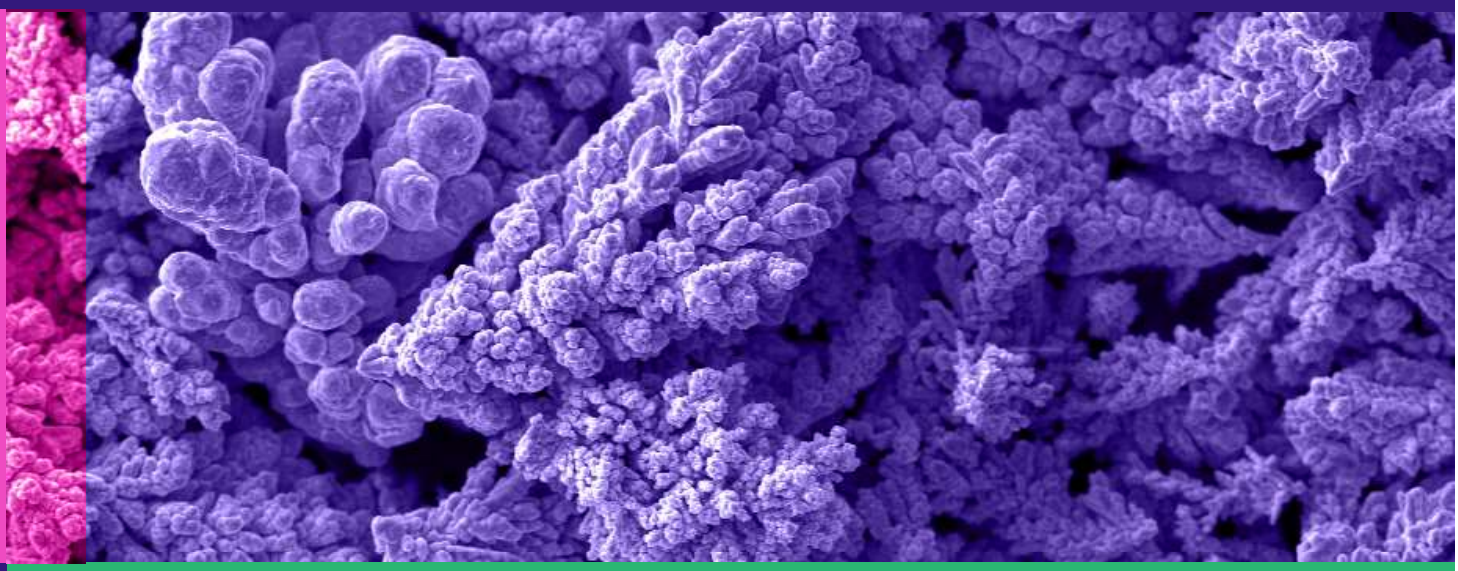

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Dynamic stimulation of superconductivity in superconductor/2D-crystal systems

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In this paper, we propose a method for the critical temperature tuning of the superconducting thin film (Nb) by modifying its phonon spectrum by a layer of graphene (G) in contact with a film. Due to the oxidation of the film surface, we have an effective superconducting structure Nb/I/G (I – insulator) with a weak bond between Nb and G. It is known [1] that in a layer of graphene with a thickness of a few atomic layers, on a top of I-layer, out-of-plane acoustic (ZA) waves are induced. Moreover, it turns out, that the spectrum of ZA-waves substantially overlaps with the phonon spectrum of Niobium. As a result of a weak interaction of Nb and G "hybridization" of the phonon spectrum of the structure Nb/I/G occurs. This is reflected in (*i*) an increase in the density of the phonon states and (*ii*) "softening" of the phonon spectrum of Niobium [2]. Consequently, the effective electron-phonon coupling constant, which is expressed through the structural function of the Eliashberg's theory [3], increases. As a result, the critical temperature of the Nb film also increases. We emphasize that for a number of superconducting materials, including Niobium, the structural function in the main frequency range (i.e., contributing to superconductivity) is proportional to the phonon spectral density. This means that the critical temperature of the film can be changed in a controlled way, affecting the phonon spectrum. Finally, we note that the described effect is similar to the effect of ultrasonic stimulation of superconductivity; the difference is that in the considered case the wave source (G) is in a thermodynamic equilibrium state with a superconducting film.

References

[1] L. Chen and S. Kumar, J. Appl. Phys. 112 (2012) 043501.
[2] W.L. McMillan, Phys. Rev. 167 (1968) 331–344.
[3] G.M. Eliashberg, Zh. Eksp. Teor. Fiz. 38 (1960) 966–976 [Sov. Phys. JETP 11 (1960) 696–702].