Abstract No. 1478

SUPERCONDUCTING NANOTUBES AND THEIR 2D CRYSTALS

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Superconductivity in nanotubes (NTs) is reviewed. Unique properties of NTs stem from phase transition connected with change of symmetry 3D - 1D under reducing of tube diameter up to nanoscale - a nanotube become a quasi-1D quantum cylinder, but macro-scopic in length. Lattices of 2D ordered bundles or ropes of NTs is expected to be a more unique. Really, a 2D lattice of superconducting noncarbon NTs was at first suggested by combining Little's and Ginzburg's ideas with recent progress in NTs research to be an ideal superconductor with record room critical temperature T_c [1,2]. Mechanism of super-conductivity was proposed on base of a whispering mode of phonon vibration, which is shown to be responsible for a strong enhancement of electron-phonon interaction and for rise of T_c and J_c. Coherent and low attenuated vibrations of all atoms pairs on diameter-opposite walls of NTs induce coherent states of their nearest electrons pairs with opposite impulses (-**k**,**k**) that provide an ideal conditions for Cooper pairing and Bose-Einstein condensation. However up to recent time a fabrication of such crystals was recognized as very difficult technological problem due to complex composition of conventional high-T_c superconducting ceramics such as YBaCuO, LuNiBC, etc.

Recent discovery of new hexagonal MgB_2 superconductor with T_c~39 K and some indications of a possible room-T_c superconductivity with T_c=400 K in carbon NTs bundles are surveyed. Puzzle of MgB_2 is hidden in it 2-gap 2-phonon superconductivity on E_{2g}-mode related with in-hexagonal-plane vibrations of B^- ions. From a "structural engineering" point of view the author's hypothesis [1,2] is here developed further, namely, a novel nanotubular multi-phonon multi-gap room-T_c superconductivity model is suggested on base of whispering gallery of circular quantum zero-points phonon modes (rotons, twistons), in particular E_{2g}, in 2D crystals built from MgB_2-type layered NTs.

Examining this fresh results one can conclude that we are now in three-step position from the synthesis of this nanotubular 2D ideal super-conductor. The first step is to obtain the nanotubes rather then nanofibers. The second is to reduce their diameter up to correlation length ξ~ 5 nm. And the third is to fabricate their ordered ropes or close-packed 2D crystals with the parameter of order of a London penetration length Λ~ 180 nm. Four routes is proposed to synthesize such record MgB_2-, Bi-, $NbSe_2$-nanotubular superconductors.

1. V.V. Pokropivny. Room-Tc super-conductivity on whispering mode in quasi-1D composite of superconducting nanotubes. Is it possible?// J.Superconductivity **13**,607 (2000)
2. V.V. Pokropivny. Composite on base of 2D nanotubular lattice as ideal high-Tc super-conductor // Physica C **351**, 71 (2001).