The Effect of Electric Field on Energy Gap and Transition Temperature of a YBCO Superconductor

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Abstract
Superconductivity is defined as the vanishing of electrical resistance of a metallic conductor, an alloy, a doped semiconductor or an insulating oxide compound at low temperature. Superconductors are classified into two classes: conventional superconductors with transition temperature (T_c) with T_c <30K and high temperature superconductors (T_c >77K, boiling point of liquid Nitrogen). High temperature cuprate superconductors have a perovskite structure. They are ceramics (solid materials combining metallic elements with non-metals usually oxygen). They are made of CuO_2 planes separated by metallic atoms. The highest achieved transition temperature of high temperature (HTSC) under high pressure is $T_c \backsimeq$ 165K. If this phenomenon of superconductivity can occur at room temperature (T_c=300K), then there will be a technological turn-around in many fields of mankind. Scientists and engineers working in this field are faced with two major tasks; explaining high temperature superconductivity explicitly and achieving superconductivity at room temperature. Superconductivity charge carriers flows along CuO_2 planes and Cooper pairs interact with each other as they flow. The interaction of Cooper pairs and positive ions leads to creation of an electric field (E) which in turn acts on the Cooper pairs. The interaction leads to perturbation of the system. The Hamiltonian of the system was formulated and converted into creation and annihilation operators for bosons and second quantization formalism used to find the value of energy gap (Δ) of the system. The energy gap was obtained and its effect on transition temperature (T_c) of a YBCO system was investigated. The effect of electric field (*E)* on an oscillating Cooper pair along the CUO_2 was found to give the value of Δ = 62.5 meV. The value of T_c was between 181K and 290K for $\rho = \frac{2\Delta}{K_B T_c}$that may lie between 5 and 8. For a typical experimental value of ρ = 6 for a YBCO system the value of T_c turns to be 240K.

Key words: Electric Field, Energy Gap, Transition Temperature.