Formation and Fluctuation-Induced Conductivity of (Tl_{1-x}Bi_x)Sr₂CaCu₂O_{7-δ} ($x = 0.1- 0.7$) Superconductor

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The (Tl_{1-x}Bi_x)Sr₂CaCu₂O_{7-δ} ($x = 0.1, 0.2, 0.3, 0.4, 0.5,$ and 0.7) samples were prepared by the solid-state reaction method. The samples were studied by powder X-ray diffraction method, electrical resistance measurements and energy dispersive X-ray analysis (EDX). All samples showed a dominant Tl-1212 phase with volume fraction approximately 85%. The Aslamazov-Larkin (AL) theory was used to analyze the excess conductivity. The dimension of fluctuation induced conductivity λ was also determined using the AL theory. The coherence length $\xi_c(0)$, Josephson coupling J , and anisotropy $\gamma = (\xi_{ab}(0)/\xi_c(0))$ of the samples was calculated using the Lawrence-Donaich (LD) theory. Substituting Bi into (Tl_{1-x}Bi_x)Sr₂CaCu₂O_{7-δ} (Tl-1212) caused an initial increase in the zero-resistance-temperature ($T_{c\ zero}$). The samples with $x = 0.3$ and 0.4 showed the highest $T_{c\ onset}$ (101 K). Excess conductivity analyses showed that Bi substitution induced 2D-to-3D conductivity transition with the highest transition temperature, T_{2D-3D} observed at $x = 0.3$. The shortest coherence length, $\xi_c(0)$ and lowest interplanar coupling, J was observed in the $x = 0.7$ which is in the under-doped state.

Keywords: Tl-1212 type phase; coherence length; anisotropy; superconductor

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