AC Susceptibility and Excess Conductivity Analysis of Cd Substituted $(\text{Tl}_{0.6}\text{Bi}_{0.4})\text{Sr}_2(\text{Ca}_{1-x}\text{Cd}_x)\text{Cu}_2\text{O}_{7-\delta}$ Superconductor

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doi: 10.20964/2018.08.06

Received: 16 March 2018 / Accepted: 10 May 2018 / Published: 5 July 2018

The effect of Cd on $(\text{Tl}_{0.6}\text{Bi}_{0.4})\text{Sr}_2(\text{Ca}_{1-x}\text{Cd}_x)\text{Cu}_2\text{O}_{7-\delta}$ (Tl-1212) superconductor is reported. Cd was chosen to partially replace Ca due to the single valence (+2) of both elements and this work is focused on the ionic radius effect on this phase. The solid-state reaction route was utilized to prepare $(\text{Tl}_{0.6}\text{Bi}_{0.4})\text{Sr}_2(\text{Ca}_{1-x}\text{Cd}_x)\text{Cu}_2\text{O}_{7-\delta}$ (Tl-1212) with $x = 0$ to 0.20. Tl-1212 was dominant as indicated by x-ray diffraction patterns. The $x = 0.15$ sample showed the highest onset temperature $T_{c\text{-onset}}$ (95 K). The peak temperature, T_p of χ'' (imaginary part of the AC susceptibility) decreased pronouncedly with Cd content indicating weakening of inter-grain coupling. Cd substitution reduced the 2-dimensional to 3-dimensional conductivity transition from 139 K ($x = 0$) to 135 K ($x = 0.15$). From Lawrence-Doniach model it was shown that the sample with the highest $T_{c\text{-onset}}$ ($x = 0.15$) exhibited the shortest coherence length, highest anisotropy ($\gamma = 9.692$) and weakest inter-layer coupling ($J = 0.421$). Cd substitution lowers both the inter-layer and inter-grain coupling. These factors are important in optimizing the superconductivity of the Tl-1212 phase.

Keywords: Tl-1212 phase; Cd substitution; coherence length; inter-layer coupling; inter-grain coupling

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