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Abu Bakar Ilhamsyah Putra, R. Abd-Shukor

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# Effects of Rare-Earth Elements and Alkali Metals on the Superconductivity of $(Tl_{0.7}M_{0.3})Sr_2Ca_{0.8}Cr_{0.2}Cu_2O_7$ with M = Gd, Er, La, Li, Na, K, and Rb

Ilhamsyah Putra Abu Bakar & R. Abd-Shukor*
School of Applied Physics, Universiti Kebangsaan Malaysia
43600 Bangi, Selangor, Malaysia

## ABSTRACT

The effects of rare-earth elements M = Gd, Er, and La and alkali metals M = K, Li, Na, and Rb substitutions on $Tl_{0.7}M_{0.3}Sr_2Ca_{0.8}Cr_{0.2}Cu_2O_7$ (Tl-1212) were investigated. The characterization includes X-ray diffraction method, scanning electron microscopy, electrical resistance and AC susceptibility measurements. X-ray diffraction patterns showed that almost all samples consisted of major Tl-1212 and minor Tl-1201 and $Ca_{0.3}Sr_{0.7}CuO_2$ phase. Rare-earth elemental substitution improved the formation of the Tl-1212 phase but suppressed the transition temperature. Scanning electron micrographs showed smaller grain size in the substituted samples compared with non-substituted sample. The temperature-dependent electrical resistance measurements showed metallic normal state behavior for all samples. Alkali metals substitutions showed higher zero transition temperature, $T_{c\text{-zero}}$ compared with the rare-earth elemental substitution. AC susceptibility measurements showed a higher superconducting transition, $T_{c\chi'}$ for alkali metals substitutions (84 – 93 K) compared with the rare-earth elemental substitutions (50 – 61 K). The inter-grain critical current density at the peak temperature $T_p$ of the imaginary part $\chi''$, $J_c(T_p)$ measured using the Bean's model was between 17 and 22 A $cm^{-2}$. The effects of rare-earth elements and alkali metals substitutions were discussed in terms of ionic radius and the concept of average Cu valence.

Keywords: Tl-1212 phase; ac susceptibility; microstructure; critical current density

*Corresponding author email: ras@ukm.edu.my