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Effects of rare-earth elements and alkali metals on the superconductivity of  $(\text{Ti}_{0.7}\text{M}_{0.3})\text{Sr}_2\text{Ca}_{0.8}\text{Cr}_{0.2}\text{Cu}_2\text{O}_7$  with M = Gd, Er, La, Li, Na, K, and Rb

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**Effects of Rare-Earth Elements and Alkali Metals on the Superconductivity of  
(Tl<sub>0.7</sub>M<sub>0.3</sub>)Sr<sub>2</sub>Ca<sub>0.8</sub>Cr<sub>0.2</sub>Cu<sub>2</sub>O<sub>7</sub> with M = Gd, Er, La, Li, Na, K, and Rb**

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**ABSTRACT**

The effects of rare-earth elements M = Gd, Er, and La and alkali metals M = K, Li, Na, and Rb substitutions on Tl<sub>0.7</sub>M<sub>0.3</sub>Sr<sub>2</sub>Ca<sub>0.8</sub>Cr<sub>0.2</sub>Cu<sub>2</sub>O<sub>7</sub> (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<sub>0.3</sub>Sr<sub>0.7</sub>CuO<sub>2</sub> 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,  $T_{c-zero}$  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<sup>-2</sup>. 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

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