# Hole Concentration of $(R_{1-x}Ca_x)Ba_2Cu_3O_{7-\delta}$ (R = Ho, Er, Tm, Yb) Superconductors

**Chia-Hsing Yian (顏嘉興)[1], Yu-Hsuen Lee (李攸軒)[1], Yu-Feng Yang (楊育峰)[1], Jia-Ling Chang (張佳玲)[1], Huey-Chuen I. Kao (高惠春)[1], and Jin-Ming Chen (陳錦明)[2]**

**[1]Department of Chemistry, Tamkang University, Taipei, Taiwan**
**[2]National Synchrotron Radiation Research Center, Hsinchu, Taiwan**

Four series of superconductors with nominal compositions of $(R_{1-x}Ca_x)Ba_2Cu_3O_{7-\delta}$ (R = Ho, Er, Tm, Yb) were prepared by the conventional solid state method. The amount of Ca doping is less than 0.2. XANES spectra of the oxygen *K*-edge and copper *L*-edge of $(Er_{1-x}Ca_x)Ba_2Cu_3O_{7-\delta}$ is shown in Figure 1 and 2, respectively. Hole concentration obtained by the oxygen *K*-edge, copper *L*-edge and iodometric titration were shown in Figure 3 for the $(Er_{1-x}Ca_x)Ba_2Cu_3O_{7-\delta}$ samples. All of these three results show that the amount of hole concentration increases with increasing the amount of Ca doping to a maximum at x = 0.050 and then decreases. The same results are found in the other three series. Figure 4 shows the relative amount of hole concentration obtained from the oxygen *K*-edge XANES spectra. The amount of Ca doping corresponding to the maximum hole concentration is plotted with ionic radius of R cation in Figure 5. The reason why a maximum hole concentration is found in these sample is not resolved yet.

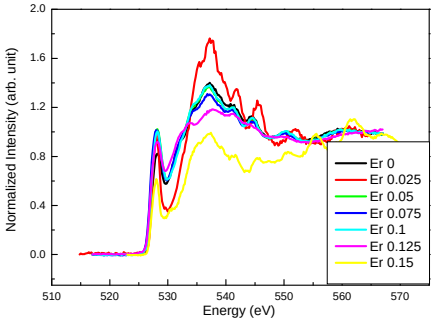


**Figure 1.** Oxygen *K*-edge XANES spectra of $(Er_{1-x}Ca_x)Ba_2Cu_3O_{7-\delta}$.

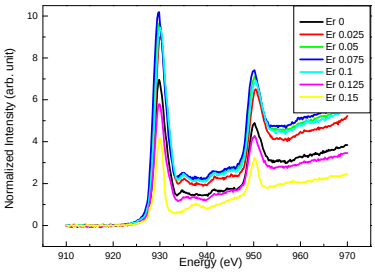


**Figure 2.** Copper *L*-edge XANES spectra of $(Er_{1-x}Ca_x)Ba_2Cu_3O_{7-\delta}$.

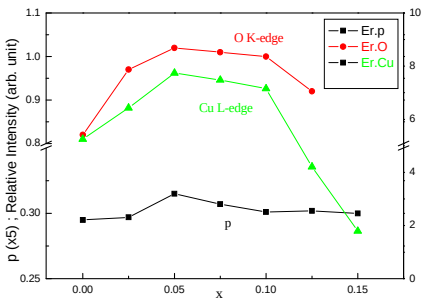


**Figure 3.** Hole concentration obtained by iodometric titration (p), oxygen *K*-edge and copper *L*-edge XANES spectra of $(Er_{1-x}Ca_x)Ba_2Cu_3O_{7-\delta}$.

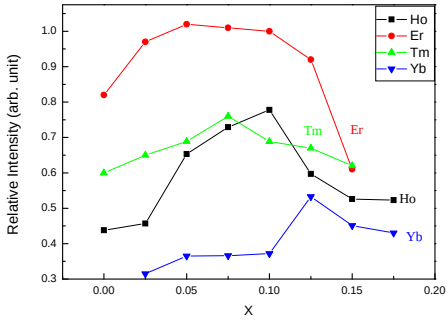


**Figure 4.** Oxygen *K*-edge XANES spectra of $(R_{1-x}Ca_x)Ba_2Cu_3O_{7-\delta}$, where R = Ho, Er, Tm, Yb.

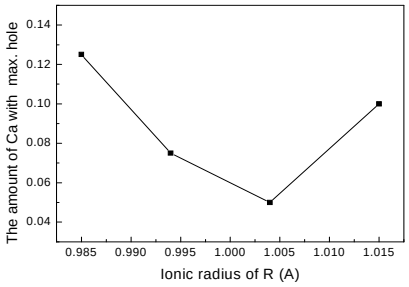


**Figure 5.** The amount of Ca substitution corresponding to the maximum hole concentration vs. ionic radius of the R cation.