

## Characteristics of $T_c$ and $\rho(T)$ of polycrystalline $(\text{In}_2\text{O}_3)$ - $(\text{ZnO})$ films with low carrier density

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For the polycrystalline  $(\text{In}_2\text{O}_3)_{1-x}(\text{ZnO})_x$  prepared by annealing in air, we have investigated the relation among superconductivity,  $\rho(T)$  characteristics and preparation conditions. To study the distribution of elements, we have investigated the micro-structure by scanning transmission electron microscopy (STEM) and electron energy-loss spectroscopy (EELS). It has been found that 1) the films annealed at restricted region of annealing temperature  $T_a$  and for time  $t_a$  show the superconductivity. Superconducting transition temperature  $T_c$  and the carrier density  $n$  are  $T_c < 3.3$  K and  $n \approx 10^{25}/\text{m}^3 \sim 10^{26}/\text{m}^3$ , respectively. 2) Although data in the  $T_c$ - $T_a$  relation are scattered depending on  $t_a$ , the  $T_c$  shows relatively good correlation with  $n$  and  $\rho$ , taking a convex form. 3) The data on EELS spectra mapping of indium plasmon indicate that droplets of the pure indium phase exist on grain boundaries and near the interface between the film and the glass substrate. However, it seems that these droplets do not form an electrical conducting path from the dispersed distribution of droplets in STEM-EELS spectra mapping.