Study of aluminum-doped zinc oxide with low infrared emissivity

Hisn-Tzu Liu[1, 2], Shi-Yao Zhong[3], Ming-Fong Tai[4], and Chih-Ming Lin[3, *]

[1]*Department of Chemical Engineering, National Tsing Hua University, Hsinchu, Taiwan*
[2]*Chemical Systems Research Division, Chung-Shan Institute of Science & Technology, Taoyuan, Taiwan*
[3]*Department of Applied Science, National Hsinchu University of Education, Hsinchu 30014, Taiwan*
[4]*Department of Physics, National Tsing Hua University, Hsinchu, Taiwan*

Abstract

For developing low infrared emissive material, aluminum-doped zinc oxide (AZO) nano-grains (NGs) powders were synthesized using a chemical precipitation method. We use both reactants of zinc nitrate and aluminum nitrate as well as urea as the precipitating agent to get precursor. Then the precursor were calcined at 400-500^{o}C for three hours. The effects of the various synthesizing parameters, including reaction temperature, reaction time, the doping amount of aluminum, and the pH value during chemical precipitation reaction, and the calcination temperature of the precursor were investigated in details. The results of inductively coupled plasma atomic emission spectrometer (ICP-AES) measurement ensured the stoichiometric ratio of Al/Zn in our ZAO powders. By the thermogravimetric analysis (TGA), precursors converted to oxides from hydroxides near about 250^{o}C and then take 500^{o}C for the temperature of the thermal processes of the precursor species. The X-ray diffraction patterns showed that ZAO powders with Al content less than 11% exhibit würtzite ZnO structure. However, their X-ray diffraction peaks shift to higher angles than those of the ZnO phase due to the smaller ionic radius of Al^{3+} ion than that of Zn^{2+} ion. The grain size of AZO NGs were calculated as 31.9, 32.5, 16.9, 16.9 and 18.5 nm for x=0.01, 0.03, 0.06, 0.09 and 0.11 by using the Williamson-Hall equation, respectively. The images of scanning electron microscopy (SEM) showed plate-like or granular. The morphology depends on chemical reaction temperature or the pH value during chemical reaction. We found that the lowest infrared absorption at λ=3-14μm was 11% ZAO and calcination temperature for the infrared absorption is not significantly affected by Fourier transform infrared spectroscopy (FTIR).

KEYWORDS: chemical precipitation method; inductively coupled plasma atomic emission spectrometer (ICP-AES); Fourier transform infrared spectroscopy (FTIR)

* To whom correspondence should be addressed.

Corresponding author at：Department of Applied Science, National Hsinchu University of Education, Hsinchu 30014, Taiwan
Tel：(886) 3-5213132-2734
Fax：(886) 3-5257178

E-mail address: cmlin@mail.nhcue.edu.tw