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The Effect of Different Fuels on Particle Size and Morphology of FTO Nano Powder Synth-sized by Gel Combustion Method

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In this study, a gel combustion method was used to prepare fluorine-doped tin oxide (FTO) nano powders. Stannous chloride dehydrate, hydrofluoric acid, and different fuels of glycine, urea, and citric acid were used to synthesize FTO nano powder, followed by calcination at 600 °C. The results showed that using citric acid as a fuel gives homogenous FTO nano powder with average particle size of 40 nm and round morphology.

Keywords: Fluorine Doped Tin Oxide (FTO), Gel Combustion, Nano Powder, Citric Acid, Glycine, Urea.

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1. INTRODUCTION

Fluorine doped tin oxide (FTO) is a n-type semiconductor material with wide band gap within 3.0 to 3.6 eV [1]. It is an advanced ceramic with many electro-optic applications due to its high electrical conductivity and transparency [2] and that's why it has been used for preparing of transparent conductive coatings [1]. Typical applications of FTO include electrodes for LCD, solar cells, energy conserving architectural windows, defogging aircraft, automobile windows, heat-reflecting coatings, antistatic coatings, and wear resistant layers on glass [2]. Various processes are reported for synthesis of FTO nano powders such as co-precipitation [3], vapor–liquid–solid (VLS) [4], sol–gel [5], emulsion technique [6], Pechini's method [7], and sol-gel combustion method [2]. Sol–gel combustion method gives a homogenous, high purity and high quality nano powders due to the possibility of stochiometric control [8]. C. H. Han et al. [2] synthesized FTO nano powder by sol–gel combustion method using acetylene black as a fuel. However, in this study, a gel combustion method was used to prepare FTO nano powder using glycine, urea, and citric acid as fuels.

2. EXPERIMENTAL PROCEDURES

$SnCl_2.2H_2O$, and HF 40% in water were used as starting materials. Urea, glycine, and citric acid were used as fuels. Table. 1 shows the characteristic of the raw materials.

For the synthesis of FTO nano powder, 8.8 g of $SnCl_2.2H_2O$ and 2 ml of HF 40% solution were dissolved in 40 ml of deionized water. Then, fuel was added to this solution. The molar ratio of fuel to metal was 1. After mixing and homogenizing of raw materials, while heating the solution, the gel combustion process was carried out. The obtained powders were calcined at 600°C for 1 h. FTO nano powders were examined by XRD. Particle and size morphology were investigated by SEM.

3. RESULTS AND DISCUSSION

XRD patterns of samples using different fuels are shown in Figure 1. As the Figure 1 shows, in all of the samples, the characteristic peaks of cassiterite structure of SnO_2 can be detected. Absence any impurity phases imply complete doping of fluorine atoms into SnO_2 structure. The doping of fluorine to the SnO_2 structure, can promote more numbers of charge carriers which results in increasing of the electrical conductivity [1].

Figure 2 shows the microstructure of samples using different fuels. The particle size and morphology of the synthesized FTO powders depend on the nature of the used fuel. Powders synthesized using urea, have the largest average particle size (~ 190 nm). This is due to a higher gel combustion rate in the presence of urea as a fuel [9]. When glycine was used, the released heat is more during combustion which yields a growth of the particle size (~ 175 nm). From the SEM images and XRD patterns, it is possible to find out that citric acid gives better results. It is likely due to the easier complex formation and homogenous gel using citric acid as a fuel [10]. Therefore, the formation temperature of the FTO nano powder can be decreased which results the smallest average particle size in comparison to other fuels (~ 40 nm).

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Table 1 – Characteristic of raw materials

№	Raw Materials	Fotmulation	Product Number	Manufacturer
1	Stannous chloride dehydrate	$SnCl_2.2H_2O$	107813	Merck
3	Hydrofluoric Acid	HF 40%	100338	Merck
4	Urea	NH_2CONH_2	818710	Merck
5	Glycine	$NH_2.CH_2.COOH$	101196X	BDH
6	Citric Acid	$C_6H_8O_7.H_2O$	818707	Merck

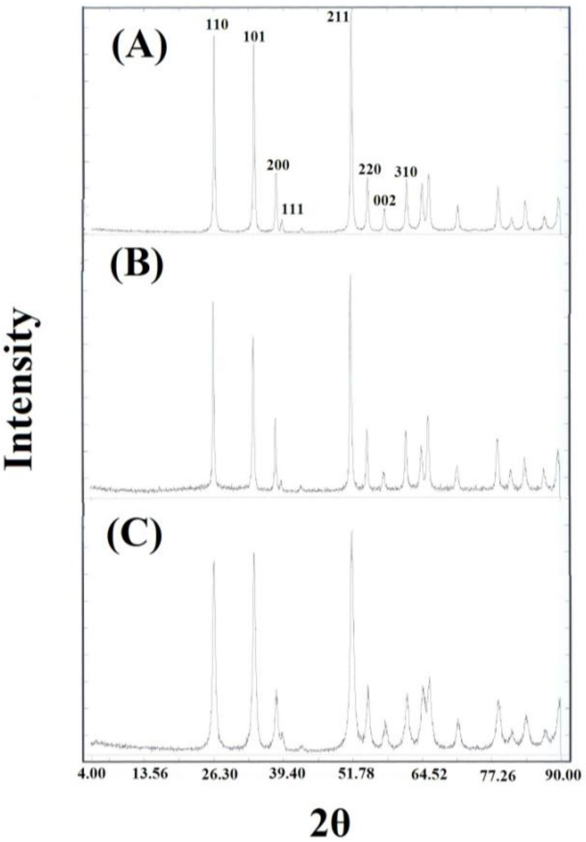

Fig. 1 – XRD patterns of FTO powders using different fuels, (A) Urea, (B) Glycine, (C) Citric acid

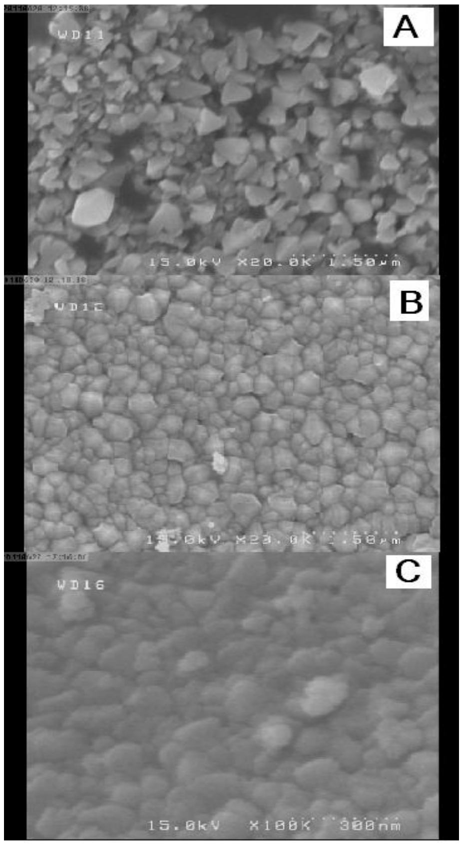

Fig. 2 – SEM pictures of FTO powders using different fuels, (A) Urea, (B) Glycine, (C) Citric acid

4. CONCLUSIONS

It is possible to prepare FTO nano powder by gel combustion method. This method gives a homogenous, high purity and high quality nano powders. Citric acid acts as a fuel in the gel combustion method and makes a suitable FTO nano powder with average particle size of 40 nm and round morphology.

REFERENCES

1. W. Z. Samad, M. M. Salleh, A. Shafiee, M. A. Yarmo, *Sains Malaysiana* **40** No3, 251 (2011).
2. C. H. Han, S. D. Han, J. Gwak, S. P. Khatkar, *Mater. Lett.* **61**, 1701 (2007).
3. K.Y. Kim, S.B. Park, *Mater. Chem. Phys.* **86**, 210 (2004).
4. B. Balamurugana, F.E. Kruis, *Appl. Phys. Lett.* **86**, 083702 (2005).
5. C.-H. Han, B. Jousseaume, M. C. Rascle, T. Toupance, H. Cacher, V. Vivier, *Fluorine Chem.* **125**, 1247 (2004).
6. P. S. Devi, M. Chatterjee, D. Ganguli, *Mater. Lett.* **55**, 205 (2002).
7. M.C. Esteves, D. Gouvea, P. T. A. Sumodjo, *Appl. Surf. Sci.* **229**, 24 (2004).
8. Z. Yue, L. Li, J. Zhou, H. Zhang, Z. Gui, *Mater. Sci. Eng. B* **64**, 68 (1999).
9. G. Neri, A. Bonavita, G. Micali, N. Donato, F.A. Deorsola, P. Mossino, I. Amatoc, B. De Benedetti, *Sensor Actuat. B-Chem* **117**, 196 (2006).
10. N. Riahi-Noori, R. Sarraf-Mamoory, P. Alizadeh, A. Mehdikhani, *J. Ceram. Proces. Res.* **9** No3, 246 (2008).