

Preparation and characterization of CuInX₂ (X=S, Se, Te) nanoparticles using the liquid polyols

Yu-Jhan Siao¹ (蕭育展), Chun-Rong Lin^{2,*} (林春榮) and Chie Gau¹ (高騏)

¹Department of Aeronautics and Astronautics, National Cheng Kung University, Tainan City 701, Taiwan.

²Institute of Nanotechnology and Department of Mechanical Engineering, Southern Taiwan University, Tainan County 710, Taiwan.

We developed a facile method to directly produce the CuInS₂, CuInSe₂, and CuInTe₂ nanoparticles in liquid polyols [diethylene glycol (DEG) or tetraethylene glycol (TEG)]. The CuCl (or CuCl₂·2H₂O), InCl₃, S, Se, Te, and NaBH₄ were used as raw materials. The CuInS₂ and CuInSe₂ nanoparticles were synthesized through reduction of raw materials in DEG while CuInTe₂ nanoparticles were prepared in TEG. X-ray powder diffraction studies show that these chalcopyrite-type nanoparticles are formed in the body-centered tetragonal structure. In addition, the mean crystallite size of nanoparticles could be controlled between 37 and 48 nm depending on the reaction temperature and reaction times. The nanoparticles were characterized by transmission electron microscopy (TEM), and x-ray photoelectron spectroscopy (XPS).

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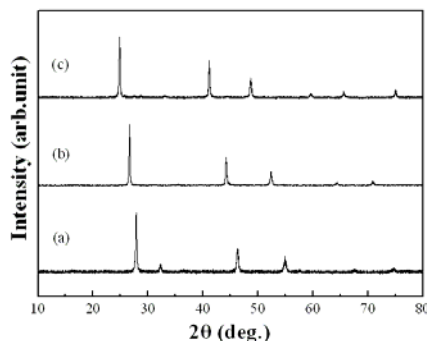
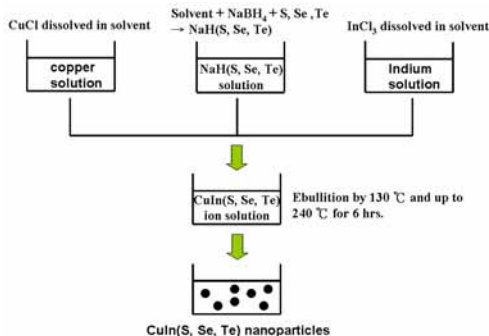


Fig 2. Powder XRD patterns of as-prepared (a) CuInS₂ and (b) CuInSe₂ and (c) CuInTe₂.

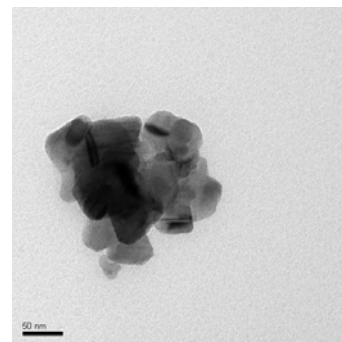


Fig 3. TEM images of the CuInSe₂ nanoparticles synthesized with DEG at 240 °C and reaction for 6 hrs

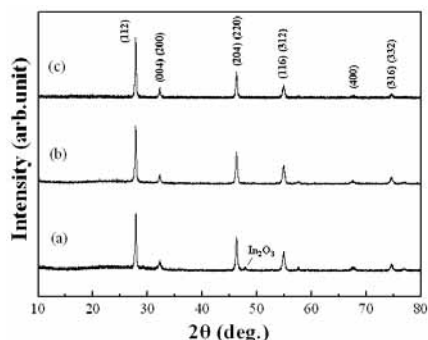


Fig 4. XRD patterns of CuInS₂ prepared in DEG at different temperatures (a) 200 °C for 2 hrs and (b) 240 °C for 2 hrs and (c) 240 °C for 6 hrs.

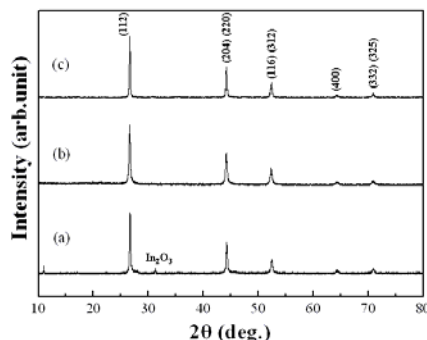


Fig 5. XRD patterns of CuInSe₂ prepared in DEG at different temperatures (a) 240 °C for 2 hrs and (b) 240 °C for 4 hrs and (c) 240 °C for 6 hrs.

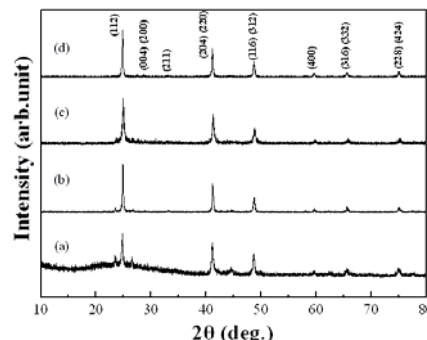


Fig 6. XRD patterns of CuInTe₂ prepared in TEG with different NaBH₄ mole ratio excessive (a) 12 mol% at 240 °C for 2 hrs and (b) 5 mol% at 280 °C for 4 hrs and (c) 11 mol% at 280 °C for 6 hrs and (d) 12 mol% at 280 °C for 6 hrs.

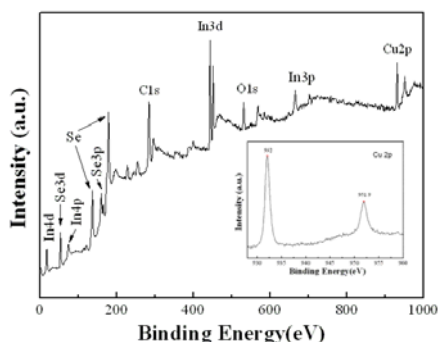


Fig 7. XPS survey spectrum of CuInSe₂ nanoparticles prepared with DEG as solvent at 240 °C for 6 hrs, the inset shows the XPS spectrum of Cu 2p of the CuInSe₂ nanoparticles.

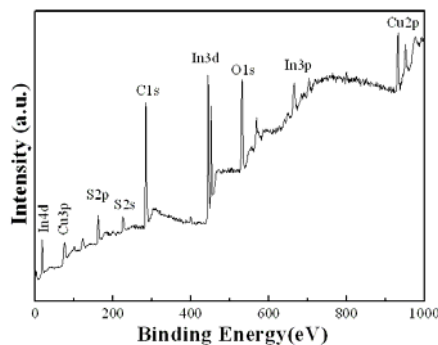


Fig 8. XPS spectrum of the as-prepared CuInS₂

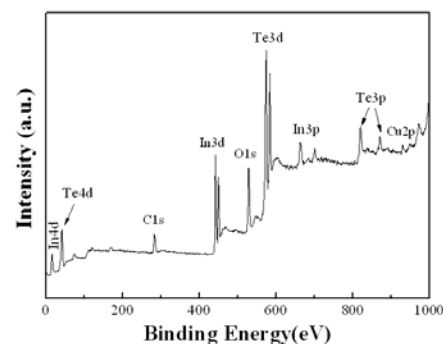


Fig 9. XPS spectrum of the as-prepared CuInTe₂

CONTACT :

Chun-Rong Lin

Institute of Nanotechnology and Department of Mechanical Engineering, Southern Taiwan University

E-mail : crlin@mail.stut.edu.tw; crlinpin@gmail.com

Tel : 886-6-253131 ext. 3547

Fax : 886-6-2425092

References

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