摘　要

本研究以 VLS 熱蒸鍍法合成出氧化銦錫奈米線，藉由改變製程溫度、氧氣的流量及來源粉末不同比率三種參數，觀察合成出之氧化銦錫奈米線形貌以及性質上的差異，尋找出最佳的奈米線製程參數後，而後將此合成出的奈米線進行光學、光觸媒特性分析並比較不同錫摻雜量之間的關係。以場發射電子顯微鏡(FESEM)分析不同製程溫度及氧流量下的奈米線形貌，在溫度偏高、氧流量太小及太大的情況下，會影響奈米線的成長及形貌，最佳狀況為 700 °C 以及氧流量 4.5 sccm 下合成出高密度的奈米線，奈米線線徑約為 200-300 nm，線長約為 10 μm。X 光粉末繞射儀(XRD)及穿透式電子顯微鏡(TEM)確認奈米線的結構為單晶的立方鐵錳礦 (Cubic Bixbyite) 結構，不會受持溫溫度及粉末比率等製程參數而改變。紫外光可見光(UV-vis)光譜圖中觀察隨錫摻雜增加，吸收峰先往長波長之後往短波長偏移，推測錫摻雜量偏高時奈米線轉變為簡併型半導體。經由紫外光可見光光譜圖和 Tauc 關係式求出氧化銦錫奈米線的光學能階，發現光學能階隨摻雜少量的錫增加而減少，隨著摻雜過多的錫增加而增加。光觸媒特性中，少量的摻雜錫進入奈米線，可有效提升光觸媒效率，但在較高的錫摻雜量下，因奈米線會轉變為簡併型半導體，使光觸媒效率降低。

Abstract

The nanowires of tin-doped indium-oxide have been synthesized by thermal evaporation via vapor-liquid-solid (VLS) mechanism. By changing the processing temperature, flow of oxygen and the different ratio of In : Sn composition, the differences in the morphology and properties of the as-synthesize tin-doped indium-oxide nanowires were then observed and evaluated. After obtaining the optimum process parameters for the fabrication of nanowires, the optical, photocatalytic properties of the as-synthesize nanowires with variation in the amount of tin doped were then analyzed. By utilizing the field emission electron microscope (FESEM), the morphology of nanowires produced at different processing temperatures and oxygen flow were observed. The growth and morphology of nanowires showed apparent changes at high temperature and under low and high oxygen flow conditions. The optimum condition to synthesize high-density nanowire was at 700 °C , with the oxygen flow of 4.5 sccm, nanowires with diameter of 200-300 nm and length of 10 μm could then be produced. X-Ray diffractometer (XRD) and transmission electron microscopy (TEM) confirmed that the structure of the nanowire was cubic bixbyite structure and did not change with the variation in processing parameters, such as temperature and In : Sn powder ratio. The Ultraviolet-visible (UV-vis) spectrum showed that as the doping amount of tin increased, the absorption peak first shifted to longer wavelength and then shifted to shorter wavelength, suggesting that

the high amount of tin-doped nanowires translated to degenerate semiconductor. By using UV-visible spectra and Tauc equation, the optical band gap of the tin-doped indium-oxide nanowires can be obtained. It was found that the optical band gap showed apparent decrease by increasing minor amount of the tin doping amount; while under excessive tin-doped conditions, the optical band gap increased with the increasing tin doping amount. Minor amount of tin doped into the nanowires can effectively enhance the photocatalytic efficiency. However, at higher amount of tin-doped conditions, the produced nanowires translate to degenerate semiconductor which then reduces the photocatalytic efficiency.