奈米磷化銦之合成與特性鑑定

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摘　　要

三五（III-V）族半導體具有共價性鍵結比二六（II-VI）族的離子性鍵結更強、毒性較低的優點。磷化銦的激子半徑大(15 nm)且具有共價性鍵結和直接能隙之電子結構，因此其奈米晶粒被期望呈現更顯著的量子效應。

本研究使用四種製程以合成奈米磷化銦，且利用 X 光繞射圖譜、X 光能譜分析儀、掃描式電子顯微鏡（或穿透式電子顯微鏡）、紫外光-可見光吸收光譜圖和光激發光光譜圖比較各產物品質之優劣。上述四種製程均可成功合成立方之奈米磷化銦，但是固態置換法和水熱法所得之產物粒徑不均勻且呈現聚集，故此兩種方法遠不及去鹵素矽化合成法。去鹵素矽化反應又因搭配配位性與非配位性溶劑作包覆試劑分兩種製程。雖然上述兩製程皆可合成奈米磷化銦，但以配位性溶劑為包覆劑之製程，產物可測得紫外光-可見光吸收和光激發光光譜圖，故為較佳之方法。此外本研究將鎵摻雜於磷化銦當中，由其紫外-可見光吸收光譜與光激發光光譜和元素分析數據，證明可成功合成

(In,Ga)P 奈米粒子。

綜上所述，本論文已建立一系列合成磷化銦之方法，亦成功合成(In,Ga)P 奈米材料，後續的研究將深入探討上述奈米材料在光電電池、螢光生物標定、發光二極體、量子點雷射等應用之潛力。

Chemical Synthesis and Characterizations of InP Nanoparticles

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ABSTRACT

The main advantages offered by III-V semiconductor nanocrystals lie in the robustness of the covalent bonding in III-V semiconductors versus the ionic bonding in the II-VI semiconductors and in the reduced toxicity of compounds. InP has a large Bohr excitonic diameter (15 nm) and its nanocrystals are expected to possess pronounced quantum confinement effects due to its covalent bonding and direct band gap electronic structure.

In this study, we have used four different methods to synthesize InP nanoparticles, which were then characterized by using X-ray diffraction (XRD), energy dispersive spectrometry (EDS), scanning (and transmission) electron microscope (SEM/TEM), UV-Vis absorption and photoluminescence (PL) spectra. The four methods can be used to synthesize cubic-InP nanoparticles successfully, which were obtained from the solid-state metathesis and solvothermal methods were found to be non-uniform and appear to aggregate, so the two methods are worse than the dehalosilylation method. The dehalosilylation synthesis can be divided into two categories, namely, one adopting coordinating (i.e.,

DDA and TOP) and the other using non-coordinating solvents. Although both preparations can produce InP nanoparticles, the method using coordinating solvent could produce nano InP as supported by apparent observation of absorption and emission in UV-Vis and PL spectra, respectively. The method using coordinating solvent is considered to be one of the best. By doping Ga^{3+} into InP using above protocol, we have observed the absorption peak in UV-Vis absorption and PL spectra for (In,Ga)P, which demonstrated the feasibility of our synthetic method.

In conclusion, this study has set up a feasible scheme to synthesize InP and (In,Ga)P nanoparticles, which can be applied with great potential in photovoltaic cells, fluorescent bio-labeling, light-emitting diodes, and quantum dot lasers in the future.