行政院國家科學委員會專題研究計畫 成果報告

奈米粒子/液晶之光譜研究(第 2 年)
研究成果報告(完整版)

計 畫 類 別 ：個別型
計 畫 編 號 ：NSC 97-2112-M-040-001-MY2
執 行 期 間 ：98 年 08 月 01 日至 99 年 07 月 31 日
執 行 單 位 ：中山醫學大學視光學系

計 畫 主 持 人：黃宣瑜
共 同 主 持 人：郭啟東

報 告 附 件 ：出席國際會議研究心得報告及發表論文

處 理 方 式 ：本計畫可公開查詢

中 華 民 國 99 年 10 月 27 日

附件一

行政院國家科學委員會補助專題研究計畫 ■ 成 果 報 告 □期中進度報告

奈米粒子/液晶之光譜研究

計畫類別：■ 個別型計畫　　□ 整合型計畫
計畫編號：NSC 97－2112－M－040－001－MY2
執行期間：　2008 年　8 月 1 日至 2010 年　7　月 31　　日

計畫主持人：黃宣瑜
共同主持人：郭啟東
計畫參與人員：

成果報告類型(依經費核定清單規定繳交)：□精簡報告　■完整報告

本成果報告包括以下應繳交之附件：
□赴國外出差或研習心得報告一份
□赴大陸地區出差或研習心得報告一份
■出席國際學術會議心得報告及發表之論文各一份
□國際合作研究計畫國外研究報告書一份

處理方式：除產學合作研究計畫、提升產業技術及人才培育研究計畫、列管計畫及下列情形者外，得立即公開查詢
□涉及專利或其他智慧財產權，□一年□二年後可公開查詢

執行單位：中山醫學大學

中　華　民　國　　九十九　年　十　　月　　二十　　日

中、英文摘要及關鍵詞(keywords)

我們利用 325nm 的 He-Cd 雷射做為激發光源，作用於奈米粒子摻雜於液晶材料中，觀測螢光光譜。隨著摻雜奈米粒子的重量百分比濃度增加，螢光強度有先增強後衰減的趨勢。螢光強度的增強為摻雜奈米粒子後，散射面積的增加，而後衰減的情形為奈米粒子產生聚集的現象。當摻雜的奈米銀粒子濃度低時，液晶的螢光經由粒子的散射使螢光訊號增強，此為粒子之表面積效應所造成的結果。當濃度漸漸增加，奈米粒子因為濃度過高而產生聚集的效應而此效應破壞了液晶排列的次序性以及聚集使奈米粒子的表面積減少，所以使得螢光逐漸的減弱。我們改變液晶導軸與激發光偏振的相對方位，發現螢光峰值強度會隨著角度增加而減弱，因液晶長軸與短軸對偏振光的吸收程度不同，而產生螢光強度的差異。摻雜不同粒徑的奈米銀粒子，發現液晶的螢光訊號皆會隨著摻雜濃度有先上升後下降的趨勢。

螢光光譜、奈米粒子、液晶

The photoluminescence of nematic liquid crystals doped with silver nanoparticles has been investigated. The peak intensity of photoluminescence varies with the concentration of doped silver nanoparticles. The peak intensity of photoluminescence shows the enhancement effect in the range of concentration from 0% to1% and the quenching effect in the range of concentration from 1%~4%. The photoluminescence can be enhanced around 55% for silver nanoparticles with 88nm in diameter.

Key words: Photoluminescence, silver nanoparticles, nematic liquid crystals

INTRODUCTION

The influence of nanoparticle on the optical phenomena has received much attention in the last decade [1–4]. An increase of luminescence intensity of dye molecules at the presence of metal nanoparticles has been observed in the early 80's [5–7]. Later, the enhancement and modification of the emission of dye molecules and trivalent rare-earth ions adsorbed onto rough metallic surfaces has been the subject of intense interest [8–11]. Noginov demonstrated that the efficiency of spontaneous and stimulated emission can be enhanced by adding the solution of aggregated silver nanoparticles to the solution of rhodamine 6G dye [12]. More recently, Hung reported the observation of an enhanced optical diffraction in cholesteric liquid crystals due to the presence of silver nanoparticles [13]. In this work, we report the photoluminescence of nematic liquid crystals doped with silver nanoparticles. The dependence of photoluminescence on the concentration of silver nanoparticles has been performed. The enhancement of photoluminescence has been demonstrated by doping nematic liquid crystals with an appropriate concentration of silver nanoparticles.

EXPERIMENTAL

The material investigated was pentyl-cyanobiphenyl (5CB) liquid crystals doped with silver nanoparticles. The size of silver nanoparticles is approximately 88nm in diameter and the weight concentration of silver nanoparticles ranges from 0~4.0%. The nematic liquid crystals doped with silver nanoparticles were capillarity injected into the sample cell, which was assembled from a pair of glass substrates coated with transparent indium tin oxide layers and spaced by a pair of 5.4-*m*m-thick Teflon sheets. The homogeneous planar alignment of the nematic liquid crystals was achieved by spin-coating a thin layer of polyimide on the inner surface of the front glass substrate, which was mechanically rubbed with a velvet cloth unidirectionally. The helium-cadmium laser with the wavelength of 325nm was employed as the excitation beam operated at an approximate power of 1 mw. The polarization of the excitation beam was maintained parallel to the director of nematic liquid crystals. The spectra of photoluminescence were measured with Jobin-Yvon T64000 spectrofluorometer at room temperature, as shown in Figure 1.

RESULTS AND DISCUSSION

The photo-induced luminescence of nematic liquid crystals was performed under the excitation of helium-cadmium laser operated at 325 nm. The photoluminescence of pure nematic liquid crystals revealed a purple-blue image, as shown in Figure 2. The photoluminescence spectrum of nematic liquid crystals without doping nanoparticles was recorded from 350nm to 500 nm. The peak position of photoluminescence was located at around 389 nm. In order to investigate the behavior of nanoparticles in the photoluminescence of nematic liquid crystals, the dependence of photoluminescence on the concentration of silver nanoparticles was performed. The photoluminescence spectra of nematic liquid crystals doping with various concentrations of silver nanoparticles were recorded for the particle size of 88 nm in diameter, as shown in Figure 3. The photoluminescence spectra of nematic liquid crystals in the presence of silver nanoparticles have the same profile as the spectrum of pure nematic liquid crystals. The peak intensity of photoluminescence as a function of concentration is shown in Figure 4. The peak intensity of photoluminescence increases with the increasing concentration of silver nanoparticles in the range of concentration from 0%~1%. The peak intensity of

photoluminescence reaches the maximum at the concentration of 1% and shows the enhancement of intensity around 55%. The peak intensity of photoluminescence decreases with the further increasing concentration of silver nanoparticles in the range of concentration from 1%~4%. The enhancement of the peak intensity of photoluminescence is attributed to the effect of local surface plasmon resonance in the range of concentration from 0%_1%. The local surface plasmon resonance effect of silver nanoparticles in the host of nematic liquid crystals becomes more obviously as the concentration of silver nanoparticles increases in this range of concentration. The decay of the peak intensity of the photoluminescence is attributed to the effect of energy transfer between nematic liquid crystals and doped silver nanoparticles in the range of concentration from 1%~4%. The partial energy of nematic liquid crystals transferring to the silver nanoparticles results in the reduction of photoluminescence intensity. The rate of energy transfer becomes higher as the concentration of silver nanoparticles increases in this range of concentration. Thus, the peak intensity of photoluminescence decreases with the increasing concentration of silver nanoparticles in the range of concentration from 1%~4%.

CONCLUSIONS

We have demonstrated that the photoluminescence of nematic liquid crystals can be enhanced by doping an appropriate amount of silver nanoparticles. The photoluminescence depends on the concentration of doped silver nanoparticles. The peak intensity of photoluminescence increases with the increasing concentration of silver nanoparticles up to certain concentration, and then decreases as the concentration increasing further.

REFERENCES

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Figure captions:

1. The experimental setup of the photo induced luminescence of nemalic liquid crystals measured with Jobin-Yvon T64000 spectrofluorometer.
2. The image of purple-blue luminescence from nemalic liquid crystals under the excitation of 325 nm.
3. The photoluminescence spectra of nemalic liquid crystals doped with various concentrations of silver nanoparticles (88nm in diameter) with
   the director parallel to the polarization of excitation beam.
4. The peak intensity of photoluminescence as a function of concentrations of silver nanoparticles.

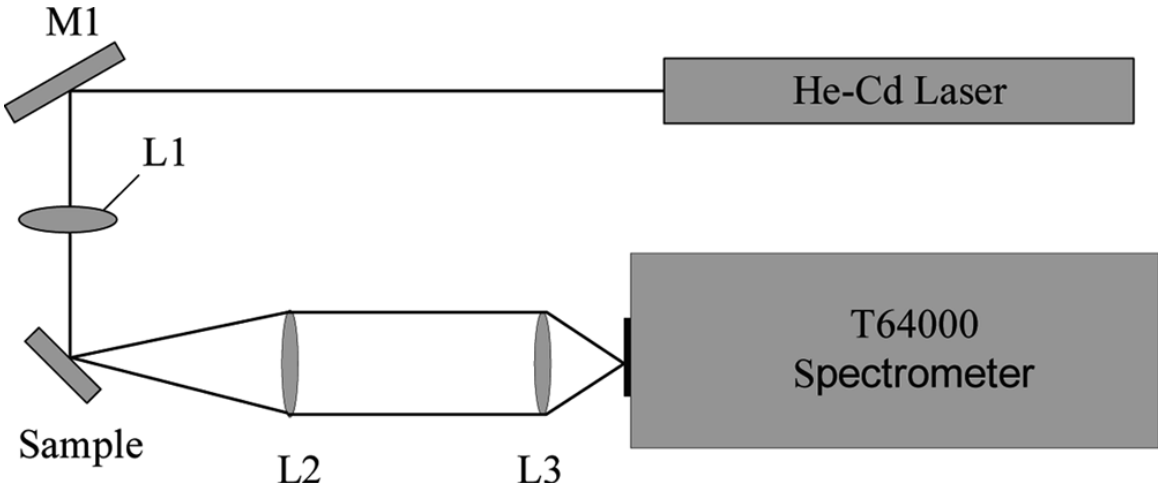

Fig. 1

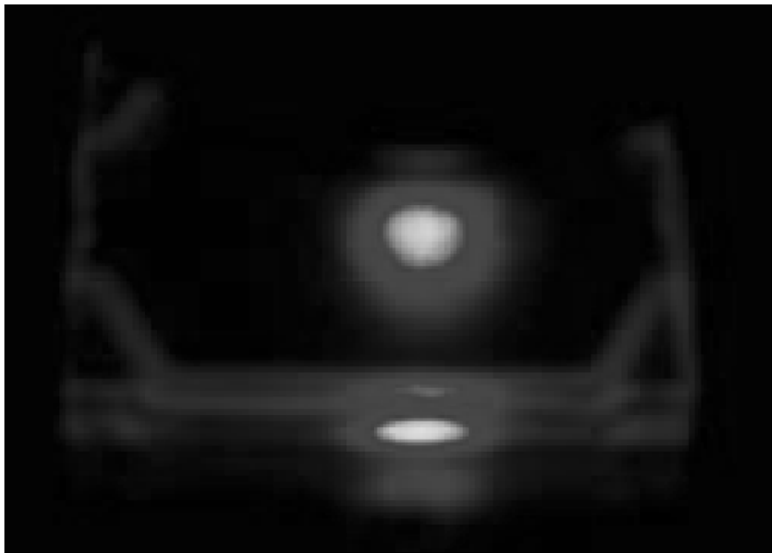

Fig. 2

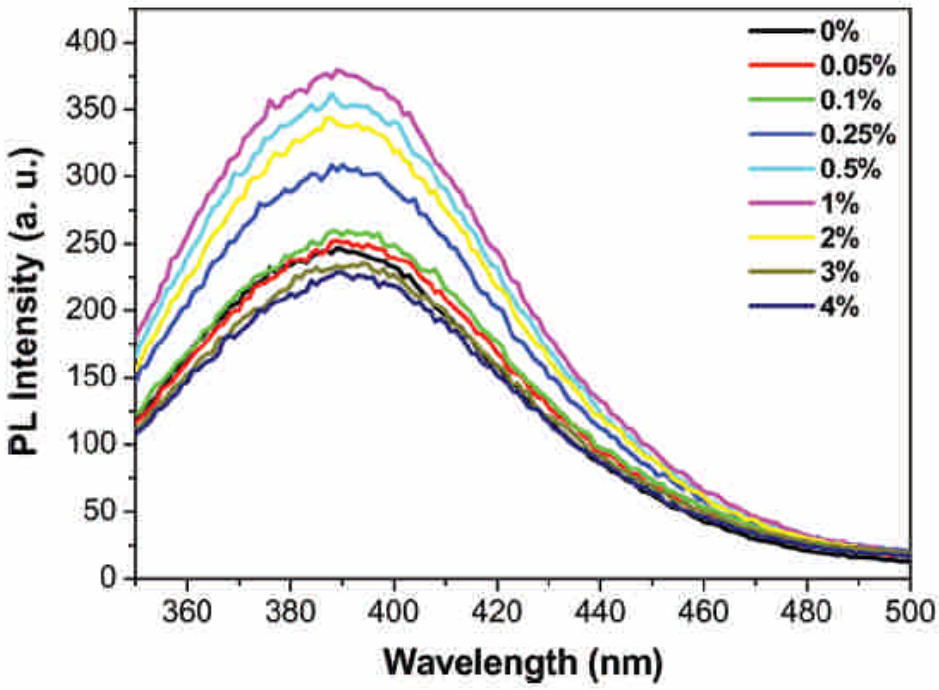
PL Intensity (a. u.)
Wavelength (nm)
0%
0.05%
0.1%
0.25%
0.5%
1%
2%
3%
4%
0
50
100
150
200
250
300
350
400
360
380
400
420
440
460
480
500

Fig. 3

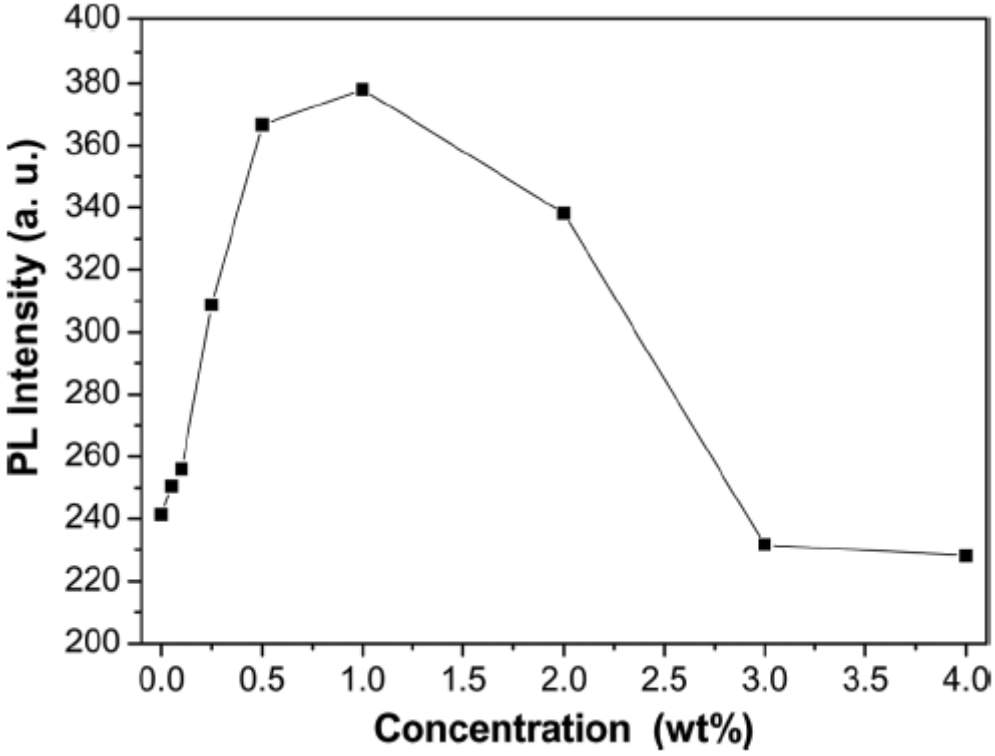
PL Intensity (a. u.)
400
380
360
340
320
300
280
260
240
220
200
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Concentration (wt%)

Fig. 4

附件二

國科會補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

■ 達成目標

□ 未達成目標（請說明，以 100 字為限）

□ 實驗失敗

□ 因故實驗中斷

□ 其他原因

說明：

2. 研究成果在學術期刊發表或申請專利等情形：

論文：■已發表 □未發表之文稿 □撰寫中 □無

專利：□已獲得 □申請中 □無

技轉：□已技轉 □洽談中 □無

其他：（以 100 字為限）

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）（以 500 字為限）

此研究成果提升了螢光的訊號，將有應用於面板的背光源訊號提升。

附件四

國科會補助專題研究計畫項下出席國際學術會議心得報告

日期：99 年 10 月 20 日

計畫編號	NSC 97－2112－M－040－001－MY2		
計畫名稱	奈米粒子/液晶之光譜研究		
出國人員 姓名	黃宣瑜	服務機構 及職稱	中山醫學大學 副教授
會議時間	99 年 1 月 24 日至 99 年 1 月 28 日	會議地點	美國 舊金山
會議名稱	（英文）Photonics West 2010 SPIE Photonics conference		
發表論文 題目	**Band-tunable color cone lasing emission based on a dye-doped cholesteric liquid crystal film**		

一、參加會議經過

此次最主要參加液晶光學與光子晶體等議程。

二、與會心得

液晶光學議程中，成大傅永貴教授及交大林怡欣教授的講題，給予在液晶光電元件許多啟發。

三、考察參觀活動(無是項活動者略)

四、建議

五、攜回資料名稱及內容

會刊

六、其他

無研發成果推廣資料

97 年度專題研究計畫研究成果彙整表

計畫主持人：黃宣瑜	計畫編號：97-2112-M-040-001-MY2
計畫名稱：奈米粒子/液晶之光譜研究	

成果項目			量化			單位	備註（質化說明：如數個計畫共同成果、成果列為該期刊之封面故事...等）
			實際已達成數（被接受或已發表）	預期總達成數(含實際已達成數)	本計畫實際貢獻百分比		
國內	論文著作	期刊論文	0	0	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	0	0	100%		
		專書	0	0	100%		
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（本國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		
國外	論文著作	期刊論文	5	5	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	3	3	100%		
		專書	0	0	100%	章/本	
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（外國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		

其他成果 (無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。)	無

	成果項目	量化	名稱或內容性質簡述
科教處計畫加填項目	測驗工具(含質性與量性)	0	
	課程/模組	0	
	電腦及網路系統或工具	0	
	教材	0	
	舉辦之活動/競賽	0	
	研討會/工作坊	0	
	電子報、網站	0	
	計畫成果推廣之參與（閱聽）人數	0	

國科會補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估 ■達成目標 □未達成目標（請說明，以 100 字為限） □實驗失敗 □因故實驗中斷 □其他原因 說明：
2. 研究成果在學術期刊發表或申請專利等情形： 論文：■已發表 □未發表之文稿 □撰寫中 □無 專利：□已獲得 □申請中 ■無 技轉：□已技轉 □洽談中 ■無 其他：(以 100 字為限)
3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）(以 500 字為限)