探討奈米晶體之仿酵素活性及其比較

關鍵字：奈米晶體、酵素性質

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壹、摘要

在生物體中，酵素扮演舉足輕重的角色。其攸關個體存亡，影響所及近乎所有器官。而一旦酵素停止作用或失去活性，就會造成嚴重的後果。如果我們可找到一種物質模仿酵素性質，就可以避免此問題，甚至可以應用於醫療上。

我們的專題主要探討奈米金屬晶體模仿酵素作用的能力，奈米金屬晶體與酵素相比較為「耐用」，能承受較極端的酸鹼值、溫度、等環境因素；而就效率而言，也絕不遜色於酵素，甚至超越酵素的效率。

貳、研究動機

自然界存在的酵素可快速且專一地用來催化物質的反應，使我們開始對這個奇妙的物質能夠擁有如此多元的多樣性感到好奇。但我們發現天然的酵素容易被環境中的因子例如 pH 值、溫度及高離子強度等影響而失去活性。

而近期奈米科技開始在此領域蓬勃發展，出現了許多新興的材料科技；又其中有研究發現部份金屬在被分解為奈米晶體的狀況下竟有近似於人體內酵素的過氧化及氧化的效果。於是，我們試想不同種類的奈米晶體在仿氧化酶及過氧化酶的效果上是否有所不同，所以本研究將著重於製備不同種類的奈米晶體，以期能獲得不同的催化效果。

參、研究目的

製備 Au、Pd、Cu 奈米晶體，以 SEM(掃描電子顯微鏡)、TEM(穿透式電子顯微鏡)觀察奈米晶體，並以實驗確認其是否具氧化酶和過氧化酶性質。

肆、研究過程及方法

一、Au 奈米晶體(Au Nanoparticles)製備

（一）將實驗器材以王水清洗。
（二）製備檸檬酸鈉水溶液，取 100.1 毫克檸檬酸鈉加入 10 毫升水。
（三）製備氯金酸溶液，取 4.95 毫升去離子水，隔水加熱。
（四）加入 0.025M、0.05 毫升氯金酸溶液(關燈)後攪拌，加熱至沸騰。
（五）加檸檬酸鈉溶液 0.05 毫升，隔水加熱 20 分鐘，此時顏色由金轉紫。
（六）取出溶液後，待冷卻至室溫，離心分離。

二、Pd 奈米晶體(Pd Nanocubes)製備

（一）0.182 克 CTAB 和 0.01 克抗壞血酸鈉溶於 15 毫升去離子純水後，在 50 ℃ 的溫度下隔水加熱並攪拌。
（二）將 0.0108 克二水合硝酸鈀溶於 5 毫升去離子純水。
（三）將步驟 3 與步驟 1 的溶液混合，隔水加熱 30 分鐘後冷卻溶液 3 分鐘。
（四）分裝兩瓶並以每分鐘 6000 轉離心 10 分鐘後去除產物上半部溶液。
（五）取一瓶加 5 毫升的純水後將兩瓶混合後以轉速每分鐘 8000 轉離心 10 分鐘。
（六）取出奈米晶體，在低溫下保存。

三、Cu 奈米晶體(Cu Nanocubes)製備

（一）量取 0.1M 乙酸銅水溶液，0.5M 抗壞血酸鈉水溶液。
（二）量取 48 毫克 CTAC，加入 9.77 毫升的水中。
（三）將 0.1M、75 微升乙酸銅及 0.5M、150 微升抗壞血酸鈉加入 CTAC。
（四）加熱至 100℃ 靜置 50 分鐘，此時溶液顏色由淡土黃色轉為深紅色。

（五）取出溶液後，待冷卻至室溫，離心分離。

四、氧化酶(Oxidase)酵素性質測定

（一）加入 0.01M、500 微升的 AA 溶液並稀釋 79.3 倍，再加入 50 微升奈米晶體。

（二）上述溶液裝入四支試管於 5、10、15 及 20 分鐘時以光譜儀測定。

五、過氧化酶(Peroxidase)酵素性質測定

（一）對照研究(Control Study)

編號／藥品	1	2	3	4
醋酸鹽類緩衝溶液 800 微升	O	O	O	O
H_2O_2 50 微升	O	O	X	O
TMB 50 微升	O	X	O	O
奈米晶體 50 微升	X	X	X	O

上述藥品在 20 分鐘後使用光譜儀測定。

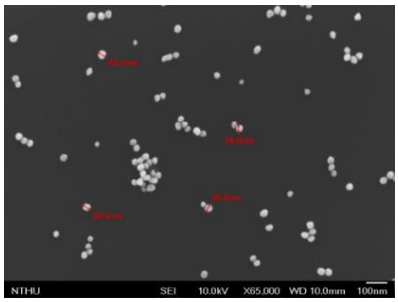
（二）時間關連性(Time Dependence)

編號 4 的藥品在 5、10、15 及 20 分鐘時使用光譜儀測定。

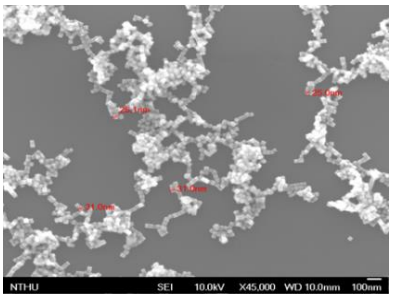
伍、實驗結果

一、奈米晶體的 SEM 影像

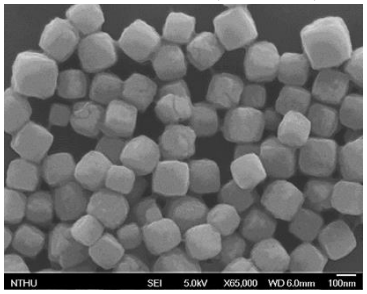
（一）Au 奈米晶體(Au NPs)



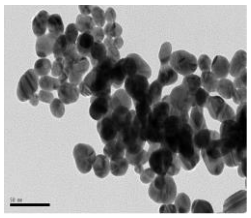
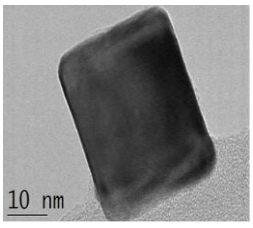
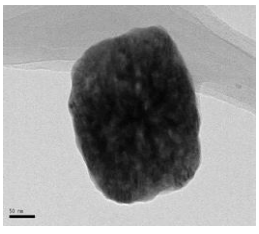
（二）Pd 奈米晶體(Pd NCs)



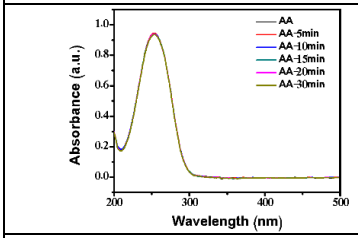
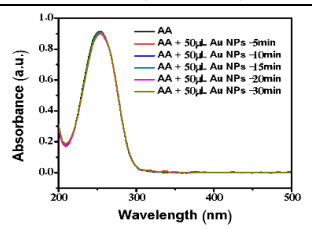
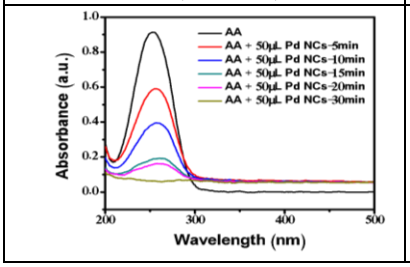
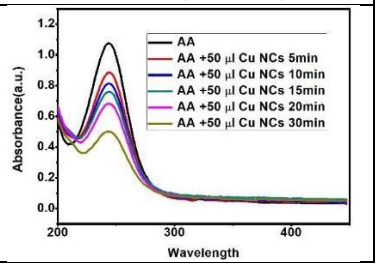
（三）Cu 奈米晶體(Cu NCs)



二、 奈米晶體的 TEM 影像

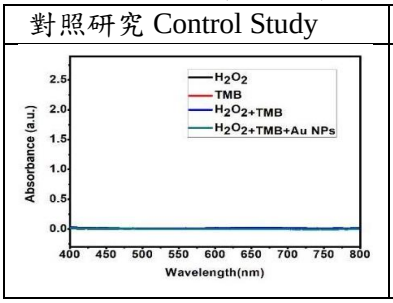
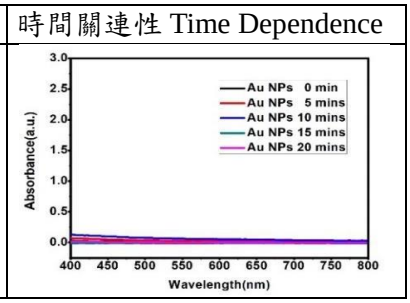
Au 奈米晶體	Pd 奈米晶體	Cu 奈米晶體
		

三、奈米晶體的氧化酶性質(Oxidase)

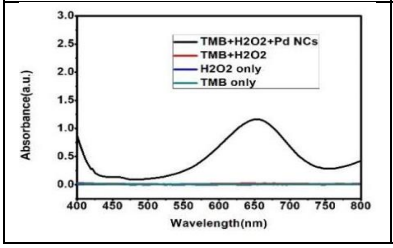
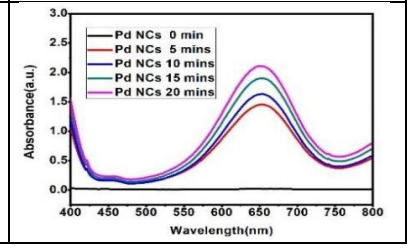
對照組，只有維生素 C(AA)	Au 奈米晶體(Au NPs)
	
Pd 奈米晶體(Pd NCs)	**Cu 奈米晶體(Cu NCs)**
	

四、奈米晶體的過氧化酶性質(Peroxidase)

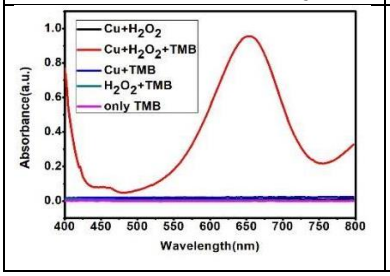
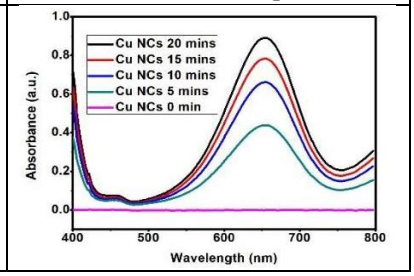
（一）Au 奈米晶體(Au NPs)

對照研究 Control Study	時間關連性 Time Dependence
	

（二）Pd 奈米晶體(Pd NCs)

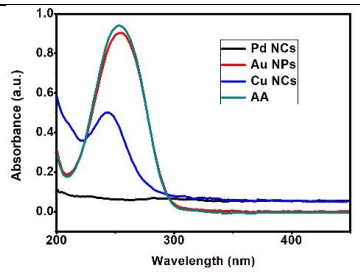
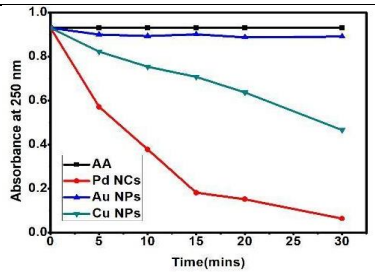
對照研究 Control Study	時間關連性 Time Dependence
	

（三）Cu 奈米晶體(Cu NCs)

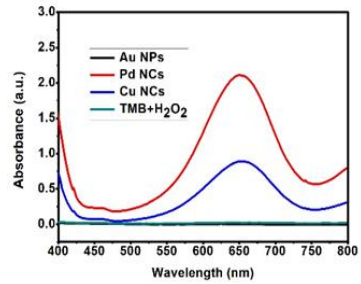
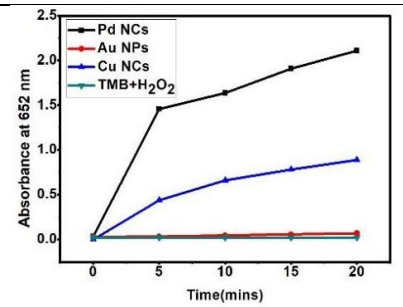
對照研究 Control Study	時間關連性 Time Dependence
	

陸、實驗討論和結論

一、奈米晶體的氧化酶性質(Oxidase)比較圖

20 分鐘後的比較圖	吸收度最高峰波長(250nm)的時間關連性比較圖
	

二、奈米晶體的過氧化酶性質(Peroxidase)比較圖

20 分鐘後的比較圖	吸收度最高峰波長(652nm)的時間關連性比較圖
	

柒、未來展望

一、探討是否有其他奈米晶體也具備酵素性質。

二、探討不同的晶體形狀和酵素性質的關係。

三、研究作用的環境是否影響奈米晶體的酵素性質，並探討奈米晶體最適合的作用環境。

捌、參考資料

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心得

This year, I learned a lot from doing the research project at NTHU. The instruments in NTHU were new and advanced. Reading English papers was a little difficult because I didn't know many scientific terms in English. I also learned the theory behind our research project. Luckily, thanks to Mr. Suresh Thangudu, who guided our experiments and always answered my questions elaborately, I could finally understand the objective of the research. I really enjoyed the time doing our project. I also appreciated my teammates for finishing our research project smoothly.

—于瑄(Sherry Yu)

It is a new experience for me to do the research project at NTHU this year. There are too many things unknown for me to learn. The sophisticated equipment, difficult theories, and the English essays really took me such a long time to be familiar with. Special thanks go to the teaching assistant Mr. Suresh for his teaching. Always be patient to answer our questions. With his explanations, I could finally understand the experiment. And I also give thanks to my teammates for doing the research with me.

—陳鈺晴(Shiny Chen)

I used to picture nanoparticles as "mythical and magical" technology. With advances of technology, nanoparticles have been applied widely in real life. During this year in NTHU, we learned about nanocrystal enzymatic activity and did various experiments. Facing the many difficulties in learning and conducting experiments, special thanks to our professor Mr.黃國柱 and our teaching assistant Mr. Suresh, the technology that I have thought to be so complicated can finally be understood.

—許家魁 (Godspeed Hsu)

教授與助教的勉勵

「師傅帶入門，修行在個人。」實驗中學科學班之同學個個資質聰穎，未來發展潛力無窮。但將來在科學領域要有所成就，仍須靠每個人自強不息、厚德載物，才能日新又新、更上層樓。

—黃國柱教授

I am a Ph. D. student in Prof. Kuo Chu Hwang lab, Department of Chemistry, NTHU. Also, as a teaching assistant I instructed some of the experiments to 于瑄, 許家魁, and 陳鈺晴 from your school.

As I personally feel that the way you are motivating the students at high school level to explore & know the ongoing research is really appreciated. In addition, the thought of this high school student program towards research is definitely create an impact on students and which is very helpful to them in future to choose research as a career.

Finally, I am very thankful for your organization to give this opportunity to me.

—Mr. Suresh Thangudu