第五章　結論

本論文探討以微波電漿化學氣相沉積(MP-CVD) 系統，在不同的溫度(550、600℃) 及氫氣條件(100、200、300 sccm)，進行前製程之參數研究。使用不同鎳觸媒厚度(1、5、7 nm)分析其對前製程的影響，再以氮化鈦(TiN)、氮化鉭 (TaN) 做為緩衝層，無緩衝層做為對照組，比較緩衝層對製程的重要性。前處理後，利用掃描式電子顯微鏡 (SEM) 觀測前處理後觸媒層表面形貌，使用原子力顯微鏡 (AFM) 進行觸媒粗糙度分析，高解析穿透式電子顯微鏡 (HRTEM) 進行晶格結構分析。結果如下：

1、鍍有緩衝層的試件比無緩衝層的試件易合成較準直的奈米碳管，證實加入緩衝層對製程的可靠度有明顯助益。

2、由於鎳觸媒易與矽基材產生矽化物，因此在無緩衝層之條件下，即使前處理觸媒顆粒適當，也不易合成出準直的奈米碳管。

3 、在具有緩衝層的製程條件下，製程參數必需相互搭配才能得到理想的觸媒顆粒。時間太短，觸媒並無法完全被催化分解成奈米顆粒，時間過長，顆粒化完成的小顆粒又會相互吸收而形成島狀顆粒。

4、觸媒層厚度對奈米碳管長度與管徑成正比趨勢；可在有緩衝層的條件之下，藉由觸媒層的厚度來控制奈米顆粒的大小。

5、鎳觸媒層在氮化鉭緩衝層上，形成顆粒較為均勻，也較其他試件容易合成出準直的奈米碳管。

第六章　未來展望

由於奈米碳管成長參數繁多，過程十分複雜，加上實驗中又充滿太多不確定因素，如機台穩定性、機台殘留氣體、前處理後氧化狀況、基材品質、觸媒附著性、人為疏失等，都會造成理論與實驗成果的差距。

目前研究至此，已有些許成果，希望能對本實驗室未來的研究有所助益，也提供從事相關研究人員一些參考。

關於之後的研究方向：

1、緩衝層對奈米碳管的特性影響 (電性、化學性、機械性質)。

2、 觸媒與基材所形成之矽化物對奈米碳管特性的影響 (電性、化學性、機械性質)。

3. 研究低溫製程下(350、450℃) 觸媒層最適當的厚度。

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