奈米碳材在質子交換膜燃料電池電極中之應用研究

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摘要

本研究是利用偏壓輔助微波電漿化學氣相方法（Bias assisted microwave plasma enhanced chemical vapor deposition）成長奈米碳管以及負正偏壓交替法成長奈米碳薄片（carbon nanoflake, CNF），再將所生成的產物應用在燃料電池電極的碳布層上，最後以物理濺鍍以及化學含浸法將白金催化劑
附著在已製備之碳布。在其中我們將討論每一製程變數所造成的影響以及提供製備電極的最佳路徑。

在製備奈米碳材時，轉換偏壓的方法可以將奈米碳管的表面改質為高表面積、高活性的奈米碳薄片，由掃瞄式電子顯微鏡（Scanning electron microscopy, SEM）可以發現奈米碳薄片從奈米碳管延伸而出，不論在大小或分佈都有良好的均勻性，進一步更可得出各種形式的薄片。其孔徑分佈可從幾十奈米至幾微米，而由穿透式電子顯微鏡（Transmission electron microscopy, TEM）可明顯看出奈米碳薄片亦具有規則排列的石墨層構造。

將碳布成長布奈米碳管以及奈米碳薄片之後，作表面積以及電阻值的量測，得到表面積增加 5～10 倍的效果，而碳布的電阻值也從 0.5Ω 降至 0.3Ω，而在附著催化劑的過程中，我們可利用濺鍍法得到均勻以及粒徑最小可達 2nm 的白金顆粒分佈，且製備過程快速簡單。反之化學含浸法必須經過冗長的前置過程，尚未能達到濺鍍的良好效果。而在循環伏安法所量測之電化學性質藉由奈米碳材的改質可獲得電流值達 0.08A 以上之提升，再配合濺鍍法可方便運用在質子交換膜燃料電池電極的製備。

Study of Carbon-Based Nanomaterials as electrode for PEMFC

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Abstract

In this study, carbon-based nanomaterials are produced in bias assisted microwave plasma enhanced chemical vapor deposition (MPCVD) by switching bias to obtain carbon nanotube(CNT) and carbon nanoflake(CNF).When applying these two materials on carbon cloth as electrode backing, two method of dispersing Pt was utilized for one is physical sputtering , the other is chemical solution immersing to compare the practicability of manufacturing process for electrode.

On the first part, the surface's property of CNT successfully improved by changing bias to form CNF. As the SEM images show that the CNF is like petals extend from the stem of CNF and the TEM also confirm its graphical structure. The pore size composed of petals could reach to several micrometers and shows the uniformity on size and distribution.

On the second part, prepared carbon cloths are characterized by BET and Four Probe point to identify their surface areas and electrical conductivity. The results indicate that CNT and CNF promote the surface areas for 5~10 times to plain carbon cloth, and the lower resistance is suitable for electrode.

Eventually, compare two methods of dispersing Pt. The sputtering could obtain uniform and particle size to 2nm of Pt distribution while the fabricating process is easy and fast. From electrochemical measurement, the current could promote to 0.08A.Thus, combine the improving carbon-based nanomaterials and sputtering, the more convenient manufacturing process is reached as an electrode for PEMFC.