以低溫燒結二氧化鈦薄膜製作延伸式閘極離子感測器

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摘 要

中文摘要 本研究以兩種方式配置二氧化鈦懸浮液，其一以四異丙醇鈦(TTIP)作為先驅物，由溶膠-凝膠法配合膠溶作用合成二氧化鈦懸浮液；另一利用商業型二氧化鈦結晶粉末(Degusa P25)直接調配鍍膜液，分別塗佈於兩種透明導電基板：ITO玻璃與ITO PET塑膠，採用水熱法處理，以達到低溫燒結的目的。論文中探討各項製程條件對於所成長薄膜的形貌、晶相、表面結構等特性之影響，並以此結構為基礎，製作延伸式閘極氫離子感測器，探討各種上述各項結構的感測特性。 由掃描式電子顯微鏡(SEM)分析中明顯發現隨水熱處理時間增加，薄膜表面TiO2團聚直徑從70nm縮小至40nm，代表水熱處理有助於TiO2團聚的分散以得到更平整緻密的薄膜結構。此點可由原子力顯微鏡(AFM)中加以驗證，當水熱時間由0小時增至12小時，表面粗糙度由17.7nm降至11.36nm；且0.5M HCl 的水溶液水熱處理後可得到最佳的表面粗糙度(4.9nm)。XRD繞射圖譜顯示所合成TiO2晶相中以鈦的水合氧化物（Titanium hydroxoides）以及含氧空缺的Ti4O7晶相為主。拉曼(Raman)分析中得知：不同水熱處理時間所得拉曼光譜，產生頻譜位移的現象，隨著水熱處理時間及系統溫度的增加，Raman shift朝向高波數方向偏移，此一現象顯示水熱處理時，樣品在高壓情況下進行晶相轉換，與文獻記載相符。膜厚量測中可知道水熱處理前、後，都有相近似的厚度。以光學監控系統n&k分析儀量測薄膜透光率，結果顯示水熱處理前後，其可見光穿透率都高於80%；實驗顯示以塑膠基材(ITO/PET)長時間水熱處理下，易造成基材劣化而提升研究的困難性。 上述結構用於水溶液中氫離子濃度的感測，探討各項製程變數對其感測特性之影響；其感測結構中可分為：(A).TiO2(Sol-Gel)/ ITO/ Glass、(B).TiO2(P25)ITO/Glass、(C). TiO2(Sol-Gel)/ITO/PET、(D). TiO2(P25)/ITO/PET；以去離子水進行水熱處理其感測結構排列為(A)>(B)>(C)>(D)，以0.5M HCl 水溶液水熱處理下感測結構排列為(C)>(A)>(B)>(D)，以0.5M NaOH 水溶液水熱處理下感測結構排為(C)>(A)>(B)>(D)。水熱處理中後發現結構(B),(D)分別在去離子水和HCl 水溶液和NaOH 水溶液水熱處理下其感測度有緩步提升的效果；而結構(A)。由以上結果可知結構(A)為最佳且穩定的感測元件，在酸鹼溶液氣氛下降低了水熱處理後的感測特性，仍始終保持穩定60μA/pH 以上的感測度。而結構(B)及結構(D)則受酸鹼溶液氣氛下提升了水熱處理後的感測特性，感測度提高至50μA/pH 以上。

關鍵詞 : 二氧化鈦，溶膠-凝膠法，水熱法

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