Fabrication of TiO2 Extended-Gate H+-ion Sensitive Electrode at Low Temperature

林彥名、廖豐標 ; 姚品全

E-mail: 9609692@mail.dyu.edu.tw

ABSTRACT

In this study, low-temperature fabricated TiO2 thin films were conducted by hydrothermal treatment with a home-made autoclave. There are two types of TiO2 stock solution. One is synthesized by sol-gel route with titanium isopropoxide(TTIP) as precursor. The other is prepared by dispersing the commercial TiO2 nanoparticles in solvent. Rigid one (ITO-glass) and conductive flexible substrate(ITO-PET) were used as substrate. The precursors were spin-coated on substrate. The as-deposited films were characterized by Raman、n&k, surface profiler, SEM、AFM and XRD, etc.. SEM photographs shows obviously that cluster diminish from 70nm to 40nm as the hydrothermal treatment time is increased from 0 to 24hrs which revealed that the clusters will be dispersed effectively under hydrothermal conditions. The facts were coincided with those derived by AFM since the surface roughness factor (Rms) is dropped from 17.7nm to 11.36nm. Besides, hydrothermal treatment can be conducted with aqueous solutions among which the 0.5M HClaq has the lowest Rms (4.9nm). The XRD patterns consist of titanium hydroxides with abundant of oxygen-deficient Ti4O7 crystalline. The Raman shift displaces toward high wavenumber as the hydrothermal process time and temperature were increased. The thickness of the films almost keep constant throughout the whole process as measured by surface profiler. Optical transmittance obtained by n&k optical system reveals that the films prepared in this study has visible light transmittance as high as 80% or above, no matter what the substrate and hydrothermal process is. The experiments show that the flexible substrate (ITO/PET) had low endurance for hydrothermal process for longer times owing to plastic degradation and will cause some difficulties in preparation. The deposited films were connect to wires and encapsulated to make the EGFET as H+ sensor in aqueous solution. The structures were divided into four categories:(A).TiO2(Sol-Gel)/ITO/Glass,(B).TiO2(P25)ITO/Glass, (C).TiO2(Sol-Gel)/ITO/PET, (D).TiO2(P25)/ITO/PET. After hydrothermal treatment with deionized water, the sensitivity of the four structures follows the sequence (A)>(B)>(C)>(D), while the samples treated by 0.5M HCl instead of DI-water under identical conditions, the sensitivity sequence becomes: (C)>(A)>(B)>(D). In contrast, as 0.5M NaOH in place of HCl, the sensitivity lists as (C) >(A)>(B)>(D). The hydrothermal process increase the sensitivity structure (B) and (D). As a conclusion, the structure (A) has highest sensitivity t and stability, which remains the stability above 60 μA/pH. while the samples treated by 0.5M HCl or 0.5M NaOH instead of DI-water under identical conditions, the sensitivity of structure (B) and (D) improved of 50 μA/pH.

Keywords : Titanium Dioxide(TiO2), sol-gel process, hydrothermal process ; system ; after

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