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RBS and PIXE study of photocatalytic track-etched membranes

During the last decade extra attention has been placed on methods of reagent less water purification based on applications of advanced oxidation processes (AOPs). Especially when using photocatalytic materials both consolidated or in suspension. Composite membrane-photocatalyst systems aim to mineralize organic substances absorbed on the membrane surface during water filtration.
In this study track etched membranes (TMs) were modified by reactively sputtering a thin film of titanium dioxide (TiO2) over the TM surface. In order to protect the TM's surface against photocatalytic oxidation a protective layer of silver (Ag) was thermally evaporated over the TM surface pre-sputter.
After investigating the resulting composite TMs, it was established that the subsequent TiO2 films had crystal structures similar to that of brookite [210] and [111].
Based on the optical properties of the system the band gaps of the composite membranes were calculated to be 3.05 eV for TiO2-TMs and 2.76 eV for Ag-TiO2-TMs respectively, the improved band gap of the Ag-TiO2 owing to the electron doping effect of the added Ag to the semiconductor.
Under the influence of UV irradiation the composite TiO2 thin films gained "super-hydrophilic" properties. By studying the kinetics of change of the water contact angle under UV radiation, it was found that after an hour the contact angle decreases to 0^{o} and the composite TM surface becomes completely hydrophilic.
The culmination of all this research regarding these multifunctional TMs resulted in their "low-absorptive", "low-fouling", "super-hydrophilic", "self-cleaning" surface property development. These composite TMs are a prospective material for future water treatment processes.
Taking into account the current high interest in creation of applied photocatalytic technology it was decided to investigate deeper into the structural properties of these composite photocatalytic layers by nuclear analytical methods.
The modified TM in this study underwent two very different sequential deposition processes. Through Proton Induced X-ray Emission (PIXE) it was confirmed that both layers were still present after sputtering as well as homogeneous. Due to PIXEs sensitivity to elemental presence it was possible to detect any trace elemental contamination, thereby refining the deposition process.
After extracting the composition profile from the Rutherford Backscattering (RBS) data and simulating those depth profiles in RUMP and SIMNRA, the elemental layer thickness could be determined from the number of atoms per unit area of the film. The RBS spectra indicated that the films were homogeneous along depth. However, an interesting phenomenon was discovered, namely, the formation of interfacial layers within the composite TMs.
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