

Optimization of Ion Implantation Parameters for Photocatalytic Coatings on Conducting and Insulating Substrates

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Titanium dioxide (TiO₂) is the most commonly used photocatalyst which is activated by UV irradiation to generate electron-hole pairs that can contribute to the destruction of inorganic compounds to water and CO₂. The photoefficiency of TiO₂ is limited in visible light due to its wide band gap and high photo-induced charge recombination rates. A potential solution to this issue is to dope TiO₂ with transition metals via low energy ion implantation (LEII) technique available at the ANSTO Centre for Accelerator Science. Previous LEII work has shown that the as-implanted dose can be significantly different from the intended nominal value when implanting insulating substrates. This can impact on the accuracy of the dosage, particularly for designing advanced materials for photocatalytic applications. Thus there is a need to investigate the effects of implanting different metals in a photocatalytic coating deposited on insulating and conducting substrates in order to determine the effect of implantation parameters on the accuracy of the implantation dosage.

This collaborative Honours thesis project between UNSW and ANSTO investigates the correlation of implantation accuracy with coating type, conductivity of substrates, and dopant type to optimise the ion implantation process. A semiconducting photocatalytic TiO₂ thin film was deposited by spin coating of sol-gel precursor (titanium isopropoxide and isopropanol) on silicon and fluorine doped tin oxide (FTO) glass substrates followed by annealing at 450°C for 2 h. The TiO₂ coated substrates were implanted with Mo and Cu ions at nominal doses of 1x10¹⁴ to 1x10¹⁶ atom/cm². The implanted samples were characterized using both particle induced X-ray emission (PIXE) and Rutherford backscattering spectroscopy (RBS) at ANSTO to determine the actual concentration of implanted dopant. The microstructural and mineralogical characteristics of the implanted samples were characterized at UNSW using scanning electron microscopy (SEM) and X-ray diffraction (GAXRD), respectively. Atomic force microscopy (AMF), X-ray photoelectron spectroscopy (XPS) and laser Raman spectroscopy were employed to determine the surface roughness, grain size, surface composition and confirmation of mineralogy of TiO₂ coated samples before and after implantation. Photocatalytic testing using dye degradation (methylene blue) under UV and solar irradiation were conducted to determine the effect of implantation on photocatalytic performance. The outcomes of this research will provide critical data which will allow for increased accuracy of ion implantation on substrates of varying conductivity and allow for optimization of implantation dosage for enhanced performance for different applications.

Level of Expertise

Student

Do you wish to take part in the poster slam

Yes

Travel Funding

No

Speakers Gender

Female

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