Indian Institute of Technology Delhi
Department of Chemical Engineering

Date: 13/10/2020

Ph.D. Viva-Voce Examination

Mr Ravi Tejasvi (2014CHZ8172) will defend Ph.D. thesis titled '**Fabrication of Titania and Carbon Nitride based Thin Film Electrodes for Photoelectrochemical Water Splitting**' on October 19 (Mon), 2020 through MS-Teams webinar in the Department of Chemical Engineering at 10:30 AM. The link will be sent separately.

All are cordially invited to attend the seminar.

Date & Time: October 19, 2020 (Mon) at 10:30 AM

Through MS-Teams (link will be sent separately).

SBasu

Prof Suddhasatwa Basu
(Supervisor)

Copy to:

1. HOD; DRC Chair
2. External Examiner: Prof. P. C. Ghosh, IIT Bombay
3. SRC Members: Prof. Anil Verma, Prof. Anupam Shukla, Prof. Bodh Raj Mehta (Physics)
4. All Faculty Members
5. DRC, Sec & Ph.D. coordinator
6. Department Notice Board – PG students
7. All HODs – for circulation

Abstract overleaf

Fabrication of Thin Film TiO_2 and Carbon Nitride Based electrodes for Photo-electrochemical Water Splitting

Abstract

Photo-electrochemical (PEC) water oxidation leads to splitting water into hydrogen and oxygen, assisted by an electrical bias. The use of the electrical bias improves the efficiency of water splitting on the electrode surface. Alternative to new material development, and for reducing the use of the electrical bias, the existing photo-active material can be combined with carbonaceous material to form heterojunction based photoelectrodes. In the presented work, a well-studied pair of photoactive semiconductor materials, titanium (IV) oxide (TiO_2) and carbon nitride (C_3N_4), has been picked-up and three different novel strategies have been devised to demonstrate efficient way to split water molecule.

Firstly, a centrifuge-based, non-evaporative method has been developed to assemble a thin film of exfoliated C_3N_4 on the conventionally used TiO_2 nanotubular array. It uses a combination of centrifugal force, fluid-particle drag force, and Van der Waals force in assembling a uniform but rough thin film of C_3N_4 on titania to fabricate a C_3N_4/TiO_2 heterojunction. Through the physical and PEC characterizations, it has been found that the centrifuge-based film deposition method achieves a photo-current density (PCD) of ~1.98 mA/cm^2 (at 1.8 V vs. Ag/AgCl in saturated KCl) as compared to the PCD of ~0.28 mA/cm^2 achieved by the similar heterojunction formed through the conventional spin coating method. In second methode, a radio frequency magnetron based sputtering method using C_3N_4 based sputtering target under Ar plasma, has been developed to form a thin film of C_3N_4 on the TiO_2 nanotubular array substrate. The method uses a sputtering target, made of bulk synthesized C_3N_4, to stoichiometrically transfer and form a thin film of C_3N_4 on the substrate, resulting in the formation of an efficient C_3N_4/TiO_2 heterojunction. The PEC studies conclude that the C_3N_4/TiO_2 heterojunction formed under Ar plasma gives current density (~290 µA/cm^2 at 0.9 V vs. Ag/AgCl in saturated KCl) higher than that for similar heterojunction formed under N2 plasma (~160 µA/cm^2 at 0.9 V). Finally, a hydrothermal method has been developed to synthesize a hierarchical, branched, and flower-like nanostructured TiO_2. The new nanostructure shows an open-flower like morphology which allows more sensitization than what can be achieved in the conventionally used TiO_2 nanotubular structure. The C_3N_4/TiO_2 heterojunction fabricated shows efficient PEC performance compared to heterojunction formed on the conventional TiO_2 nanotubular structure. It has been found that the PCD of the C_3N_4/TiO_2 heterojunction has nearly doubled, from ~0.6 mA/cm^2 (at 0.9 V vs. Ag/AgCl in saturated KCl) for nanotubular array heterojunction to ~1.1 mA/cm^2 for nanoflower based heterojunction. Furthermore, it is also shown that, unlike anodization, the new method provides an avenue for the recovery of exhausted fluoride.

Keywords: C_3N_4/TiO_2 heterojunctions, C_3N_4 nanoflake assembly, RFM sputtering, TiO_2 nanoflower, C_3N_4 thin film electrode