SNBNCBS THESIS COLLOQUIUM

Azadi Ka Amrit Mahotsav

Date	3rd December, 2021
Time	03:00 PM
Venue	Boson Hall
Link	https://meet.google.com/mcb-jfyt-fsb
Speaker	Mr. Dipanjan Maity
Supervisor	Prof. Kalyan Mandal
Department	CMP&MS

Thesis Title

Solar Energy Harvesting In A Photoelectrochemical Cell: Development Of Photoanodes Based On Earth Abundant Materials

Thesis Abstract

Photoelectrochemical (PEC) water splitting is the most elegant way to capture and store solar energy as chemical fuel i,e, hydrogen (H_2). H_2 is considered the most suitable alternative fuel that can replace fossil fuels in the near future due to its high energy density and environmental friendliness. Since the discovery of water splitting by Fujishima and Honda in 1972, using TiO_2 as a photocatalyst, several metal oxide semiconductors such as ZnO, Fe_2O_3, WO_3 have emerged as photoelectrode materials. Among them, ZnO is the most widely studied photoanode material due to its natural abundance, low cost, facile synthesis, low toxicity to the environment, carrier mobility, and suitable band position with respect to water oxidation and reduction potential. However, Poor light absorption, severe charge recombination, and fast degradation under illumination inside an aqueous medium are the critical challenges with ZnO-based nanostructured photoanodes for photoelectrochemical (PEC) water splitting cell applications. To overcome these limitations, heterojunction formation between ZnO and other functional materials is considered the most promising pathway. This projected thesis is focused on the fabrication of different types of heterojunction (p/n, n/n) photoanodes using ZnO as a primary material. An n-n type heterojunction between ZnO and MoO_3 significantly improved the photocurrent density to 27.6 μAcm^{-2} from 3.3 μAcm^{-2} of pristine ZnO photoanode at 1.23V vs. RHE. The randomly originated oxygen vacancy in MoO_3 creates mid-band-gap defect states, enhancing the overall absorption of the heterojunction photoanode; the band alignment between ZnO and MoO_3 boosts the charge transfer process. The construction of efficient and durable nano-heterojunction photoelectrode by integrating MFe_2O_4 (M = Co and Ni) nanoparticles on ZnO Nanorod arrays resulted in a maximum increase of 105% and 190% in photocurrent density and applied bias photon-to-current efficiency, respectively, compared to pristine ZnO nanorods. The one-dimensional, type-II analogous n-ZnO/p-ZnCo2O4 nanoheterojunction photoanode exhibits an improved solar light-harvesting performance over pristine ZnO photoanode. The hetero alignment accelerates the charge separation and transfer, significantly reducing the photogenerated electron-hole pair recombination. The dual co-catalysts modified Fe_2O_3 nanorods photoanode by strategically incorporated CoPi and $Co(OH)_2$ exhibits a photocurrent density of 0.55 mA cm^2 at 1.23 V vs. RHE, 358% higher than that of pristine Fe_2O_3 nanorods with an ultra-low water oxidation turn-on potential of 0.4 V vs. RHE. . Overall the dual co-catalysts overlayer improves the oxygen evolution reaction kinetics and electrical conductivity for hematite NRs, resulting in improved PEC water oxidation.

References

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