Seminar

Institute for Plasma Research

Title : Photoelectron spectroscopic studies of solar cell absorber materials

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Date : 26th July 2021 (Monday)

Time : 03.30 PM

Venue : Online - Join the talk: https://meet.ipr.res.in/Dr.IshetaMajumdar_PDFTALK

Abstract :

A rise in conversion efficiencies of Cu(In,Ga)Se2 (CIGSe)-based solar cells in recent years due to alkali treatment of CIGSe absorbers led to the topic of my doctoral thesis work, which will be the central point of discussion of this talk. My PhD thesis work presents a comprehensive study of the surface modifications at the CIGSe absorber surfaces as a result of treatment with alkali elements sodium (Na), potassium (K) and rubidium (Rb), in terms of qualitative and quantitative chemical analysis (changes in elemental concentrations) and changes in energy band (valence band maxima) positions. A combination of lab-based soft X-ray photoelectron spectroscopy (XPS), ultra-violet photoelectron spectroscopy (UPS) and synchrotron-based hard X-ray photoelectron spectroscopy (HAXPES), X-ray absorption near-edge structure (XANES) spectroscopy as well as electrical measurements (J-V), numerical simulations (SCAPS) and chemical system modelling (DFT) has been used to gain a deeper insight into the chemical and electronic effects of the alkali treatment on absorber surfaces and at absorber/buffer interfaces, which are the key areas that determine the open-circuit voltage (Voc) and fill factor (FF) enhancement in solar cell devices. I will also discuss the effects of alkali-induced defects at the absorber/ buffer interfaces of thin-film CIGSe/CdS stacks in order to find a correlation with real solar cell device performances for which, I was able to develop lab-scale CIGS-based solar cell devices of +4.7 % improved efficiencies.

For my future work as PDF, I will propose an idea, which will be in the field of organic electronics. It would be interesting to develop an innovative approach where an ultra-thin metal-oxide film is interposed between the organic film and the buried electrode. In this regard, a combination of different electron spectroscopic techniques have to be adopted to monitor the stability of the Highest Occupied Molecular Orbital - Lowest Unoccupied Molecular Orbital (HOMO-LUMO) gap when the organic film is deposited on the electrode and to verify that no extra, interface states are produced during the film growth. The proposed research theme anticipates to open a new approach in the field of organic/metal electrode coupling, trying to minimize the interaction and overcome the current bottleneck in organic electronic device preparation.