Research topic Copper metallisation #2: Copper metallisation for amorphous/crystalline silicon (Si) heterojunction solar cells

Amorphous/crystalline Si (a-Si:H/c-Si) heterojunction (HET) solar cells are a hybrid Si wafer/thin film cell type with the potential to reach very high open-circuit voltages (and hence high energy conversion efficiency) due to the excellent interface passivation provided by intrinsic a-Si:H layers. This is exemplified by the current record for the highest efficiency of a Si based (non-concentrating) solar cell: 25.6% for a back-contact HET cell developed by Panasonic.

The typical structure of HET cells includes an n-type Si wafer base, capped on both sides with intrinsic a-Si:H layers, a p' doped a-Si:H layer on the front as the emitter (or hole collector) and an n' a-Si:H layer on the rear as the back surface field (or electron collector). Electrodes for HET cells are formed by transparent conductive oxide (TCO) layers like aluminium doped zinc oxide (AZO) or indium tin oxide (ITO) and metal contacts. The TCO layer's primary function is to provide a lateral conduction and antireflection layer for HET cells. Although additionally the TCO layer for HET cells can also serve as a diffusion barrier for impurities to Si and therefore even metals with high diffusivity in Si (for example Cu) can be used for the metallisation of HET cells. Hence, Cu is an excellent alternative to more expensive metals like silver (Ag) for HET cell metallisation.

HET cells are in development at SERIS and the focus of this PhD research will be the development of novel and industrially feasible metallisation methods for HET cells. The experimental work is likely to focus on electrochemical deposition of Cu (plating) and screen printing of Cu pastes for the metallisation of HET cells using state-of-the-art industrial (pilot-scale) tools. The goals include development of efficient methods to mask the TCO surface before plating, improving the adhesion of Cu to TCO layers, achieving simultaneous plating of both surfaces of bifacial HET cells, evaluation of TCO layer performance as barriers for copper diffusion to silicon, and implementation of Cu metallisation on high-efficiency HET cells. The research will also investigate the stability of Cu metallisation in PV modules.

Cu plated HET cells and cell precursor structures will be extensively characterised using mechanical (peel-strength for metal adhesion tests), electrical (examples: contact resistance measurement, Suns-Voc measurement, finished cell current-voltage measurements) as well as microstructural (examples: scanning electron microscopy, energy dispersive spectroscopy) characterisation techniques.

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