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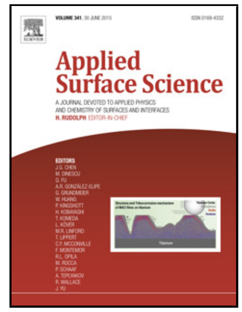

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Inductively and capacitively coupled plasmas at interface: a comparative study towards highly efficient amorphous-crystalline Si solar cells

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Highlights

This work contains several new important results of broad interest. In particular we demonstrate:

- An efficient application of ICP-CVD and PECVD techniques for the improvement of the passivation quality and the minority carrier lifetime;
- Efficient band gap adjustment at sophisticated interfaces at low temperatures, low RF powers and short processing times.

ABSTRACT

A comparative study on the application of two quite different plasma-based techniques to the preparation of amorphous/crystalline silicon (a-Si:H/c-Si) interfaces for solar cells is presented. The interfaces were fabricated and processed by hydrogen plasma treatment using the conventional plasma-enhanced chemical vacuum deposition (PECVD) and inductively coupled plasma chemical vapour deposition (ICP-CVD) methods. The influence of processing temperature, radio-frequency power, treatment duration and other parameters on interface properties and degree of surface passivation were studied. It was found that passivation could be improved by post-deposition treatment using both ICP-CVD and PECVD, but PECVD treatment is more efficient for the improvement on passivation quality, whereas the minority carrier lifetime increased from 1.65×10^{-4} to 2.25×10^{-4} and 3.35×10^{-4} s after the hydrogen plasma treatment by ICP-CVD and PECVD, respectively. In addition to the improvement of carrier lifetimes at low temperatures, low RF powers and short processing times, both techniques are efficient in band gap adjustment at sophisticated interfaces.

Keywords: Solar cells; plasma

1. Introduction

Efficient control of interfacial properties and managing carrier recombination rates at the interfaces of crystalline (c-Si) and amorphous silicon is a critical aspect for the fabrication of highly efficient Si interface-based [1,2], heterojunction solar cells [3,4]. Both termination of dangling bonds by chemical passivation and repelling of minority carriers by strong electric fields at the surface of c-Si can effectively reduce surface recombination rates [5,6]. Application of intrinsic amorphous silicon thin films (a-Si:H) in solar cell technology has demonstrated its capability of providing excellent chemical passivation of c-Si