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Microcrystalline silicon solar cells fabricated by VHF plasma CVD method

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Abstract

A series of systematic investigations on microcrystalline silicon (μc-Si:H) solar cells at high deposition rates has been studied. The effect of high deposition pressure and narrow cathode-substrate (CS) distance on the deposition rate and quality of microcrystalline silicon is discussed. The microcrystalline silicon solar cell is adopted as middle cell and bottom cell in a three-stacked junction solar cell. The characteristics of large area three-stacked junction solar cells, whose area is 801.6 cm^2 including grid electrode areas, are studied in various deposition rates from 1 to 3 nm/s of microcrystalline silicon. An initial efficiency of 13.1% is demonstrated in the three-stacked junction solar cell with microcrystalline silicon deposited at 3 nm/s.

Keywords: Microcrystalline silicon; High deposition rate; Solar cell; Three-stacked junction; VHF plasma

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1. Introduction

Silicon thin film solar cell is a promising candidate for the high efficiency, low-cost next generation solar cell [1]. As has been reported elsewhere that high quality with high deposition rate of μc-Si:H i layer are the key technology for the high efficiency with low cost solar cell. Recently Neuchatel group reported the results of μc-Si:H solar cell [2]. We have already shown that the two stacked a-Si/μc-Si:H solar cell could have a high efficiency at high rate with high quality [3–8]. The deposition mechanism of μc-Si has been aggressively studied [9–12]. A high-pressure deposition method was proposed to deposit a μc-Si:H film at high rate [10]. To fabricate cost-effective three-stacked junction solar cells, we have increased the deposition rate of device quality μc-Si:H by adopting the high-pressure VHF PCVD method and have improved it.

In this paper, it is reported on the correlation of the deposition rate with the deposition pressure and the CS distance and on the correlation of the efficiency with the deposition pressure and the CS distance. Then this method is applied to fabricate large area three-stacked junction solar cells at high deposition rates by using the roll-to-roll machine. The characteristics and light-induced degradation rate of the large area three-stacked junction solar cells will be reported.

2. Experiment

A schematic diagram of the roll-to-roll processing machine for the solar cell fabrication is shown in Fig. 1. The roll-to-roll machine consists of a lot of chambers, that is, the stainless-steel roll web is paid out to the n+ chamber and taken up after the p+ layer deposition is finished. The chambers are connected by the gas gates, which avoid inter-diffusion of source gases between adjacent chambers. We designed

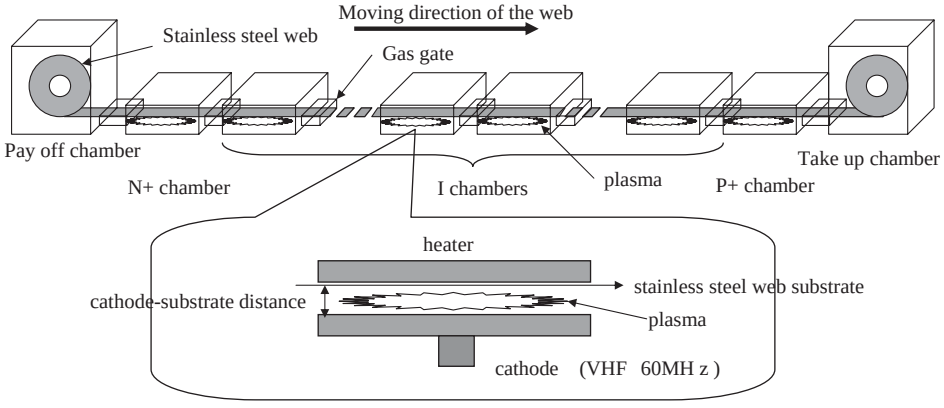

Fig. 1. Roll-to roll machine.