Optical Confinement Type a-Si:H Solar Cell Using Milky Tin Oxide On Glass

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Abstract- The new structure of optical confinement type a-Si:H solar cell using milky tin oxide on glass(MTG) is proposed. This structure has a native textured large grain size tin oxide film and a core-clad structure like an optical fibre or optical waveguide. The conversion efficiency of 10.26% with Jsc=22.3mA/cm^{2}was achieved in this structure.

INTRODUCTION

There are many trials for improving long wavelength sensitivity of a-Si:H solar cell, that is, tandem structures used a-SiGe:H[1] a-SiSn:H[2] and other narrow band gap semiconductor materials have been exsamined. On the other hand, the structuer which used the optical confinement effect,for example, using large grain size SnO_2[3] and textured glass substrate[4] have been also reported. The above methods were still insufficient for potical confinement. In this report, the advanced optical confinement type structuer which used milky tin oxide on glass(MTG)[5] substrate is proposed to realize much larger short circuit current than the previous structures and the results of preliminary experiments also reported.

CONCEPT OF OPTICAL CONFINEMENT TYPE SOLAR CELL

The concept of the more effective optical confinement type a-Si:H solar cell can be summarized as follows;

(1) The optical pass length inside the semiconductor active layer (a-Si:H intrinsic layer in this case) is made longer by changing the direction of incident beam from nearly vertical to as horizontal as possible to the active layer.
(2) The semiconductor active layer is sandwiched by a pair of clad layers with smaller refrective index than active layer.
(3) The reflection layer is useful for returning the light beam which pass through the clad layer of back electrode side to the active layer again.

To realize the above concept, use of the following materials and structures are feasible;

(1) A textured transparent electrode for insident side such as MTG.
(2) The conbination of the textured front electrode and a transparent back electrode as a pair of clad layers.
(3) Another reflective Al or Ag electrode on the transparent back electrode.

EXPERIMENT

Fig. 1 shows the advanced structuers of the optical confinement type a-Si:H solar cell experimentally fabricated. (A) and (B) are cells using MTG substrates (average grain size more than 0.1μm) with reflector and without reflector respectively. (C) is a case of using ordinary small grain size SnO_2 (less than 0.05μm) film on ITO film. In this figure, a is the glass substrate(Corning 7059,

t=0.5mm). b is the first clad layer and consists of large grain size SnO_2 film or small grain size SnO_2 on ITO film, these SnO_2 and ITO films are prepared by spray method and electron beam deposition method respectively. The grain size of SnO_2 was controlled by film thickness and temperature[3]. The film thickness of MTG is about 0.8μm (cell A and B), those of SnO_2 on ITO are 0.05μm and 0.2μm respectively(cell C). c is p(a-SiC:H)[6], i,n layer by RF glow discharge method. d is the second clad layer and it consists of ITO film by electron beam deposition method. This film thickness is about 0.07μm. e is an aluminium or silver electrode and plays a role of reflector. The cell area is about 2x2 mm^2. The conversion efficiency of these cells are estimated simulated AM1 insolation.

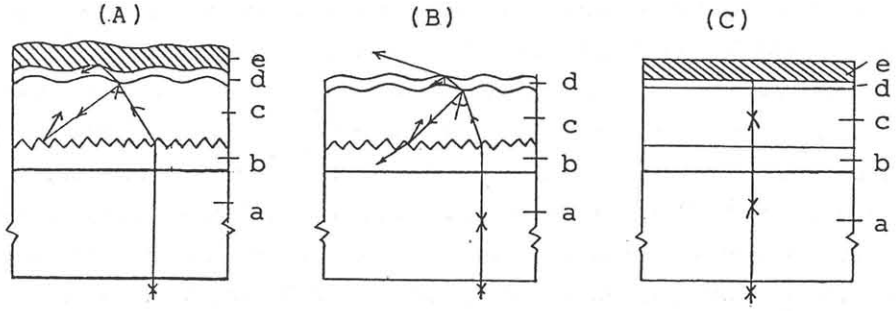

Fig. 1 The structure of optical confinement type a-Si:H solar cells using MTG(cell A and B) and ordinary grain size transparent conductive electrode(cell C).

The magnitude of short circuit current is always (A) > (B) > (C) in this order. The conversion efficiency of 10.26% has been obtained with Jsc=22.3mA/cm^2, Voc=0.802 V, FF=57.3% at structure (A). The area of this cell is 4.46 mm^2.

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