● Evaluation of thin film silicon solar cell

TNE0010

Overview

Although thin film silicon solar cells have lower conversion efficiency than crystalline solar cells, (1)They use a much smaller (approximately one hundredth) amount of silicon (resource saving), (2)They can easily be manufactured more cheaply (mass production), and (3)They can be formed into light and flexible modules. For these reasons, the market for thin film silicon solar cells is expected to grow. Amorphous silicon solar cells are an example of thin film silicon solar cells. Figure 1 shows how the p-i-n structure enclosed by electrodes is formed on the substrate. SCAS evaluates the film thickness, impurities (dopants) and crystal properties etc that contribute to conversion efficiency and photo-deterioration. Two examples of the evaluation of a commercial amorphous silicon solar cell follow.

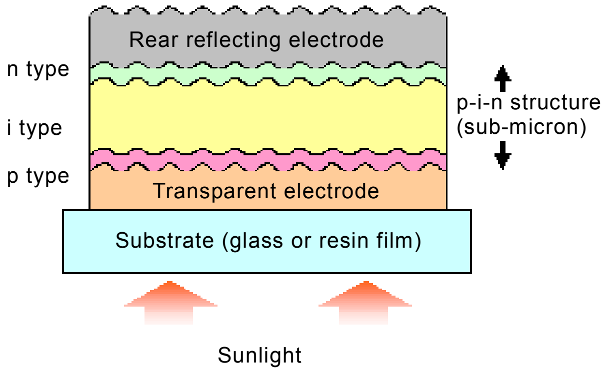

Fig.1 Basic structure of amorphous silicon solar cell.

Example I: Evaluation of film thickness and crystal properties of cell structure by observation of cross section

The film thickness and texture of the cell structure can be determined by taking a thin slice and observing it under the transmission electron microscope (TEM). Interface segregation impurities and the crystal properties can also be evaluated by elemental analysis and electron diffraction.

Figure 2 is a TEM micrograph of the overall structure of the cell. The image confirms the rear reflecting electrode, amorphous silicon, transparent electrode film structure. Elemental analysis shows that the rear reflecting electrode is an AI film and the transparent electrode is a SnO_2 film.

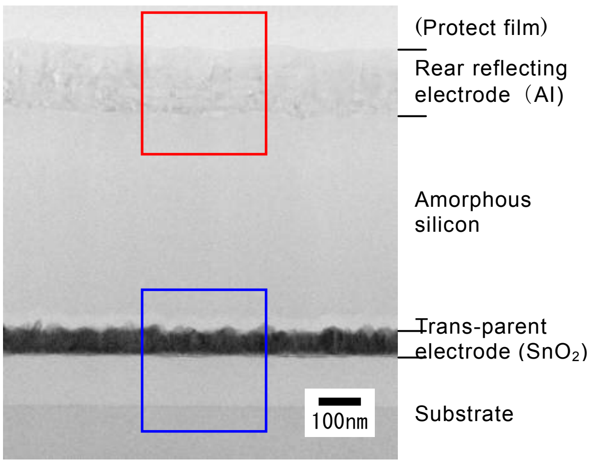

Fig.2 TEM micrograph of cross section of solar cell.

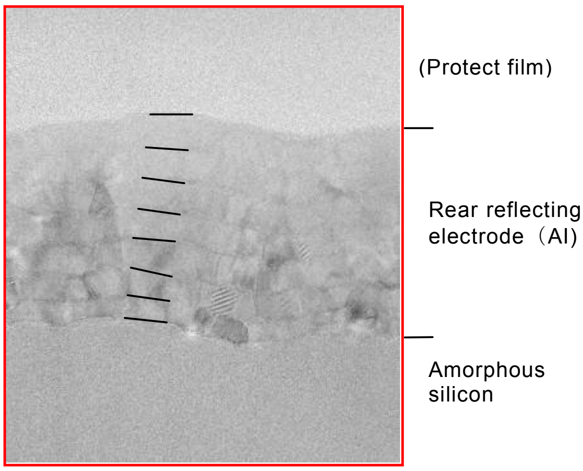

Fig.3 Expanded TEM micrograph of rear reflecting electrode (Al).

Next, the expanded view of the transparent electrode (SnO_2) (Fig. 4) shows that the SnO_2 crystals produced by sputtering as well as the rear reflecting electrode (Al) grew in a relatively random way, which produced a texture. A single layer of film was formed between the glass substrate and the transparent electrode. The results of secondary ion mass spectroscopy (SIMS) in Example II below show that it was a P-doped SiO_2 film.

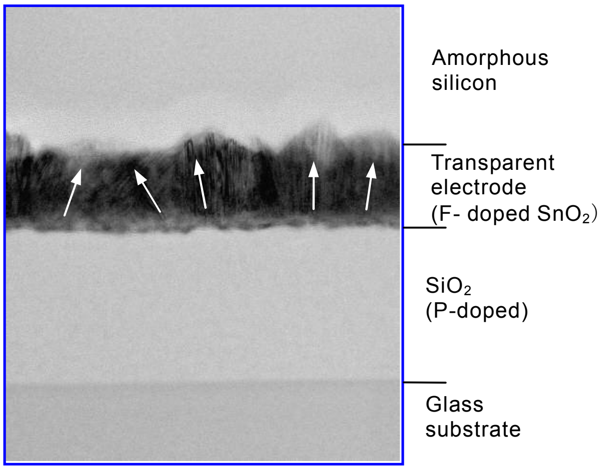

Fig.4 Expanded TEM micrograph of transparent electrode (SnO_2).

Example II: Evaluation of process gas components and dopants in (p-i-n structure) cell by depth direction analysis

Films are formed by CVD on p-i-n structured cells, but the level of impurities (process gases and dopants) and the level of hydrogen in the amorphous silicon hydride affect conversion efficiency and photo-deterioration.

Figure 5 shows the result of SIMS analysis of an amorphous silicon solar cell (same sample as Example I). The hydrogen and oxygen in the rear reflecting electrode (Al) exhibit distributions that suggest a seven-layer structure, the hydrogen and oxygen levels in the p-i-n structure are higher in the n layer than in the p or i layers, and the transparent electrode (SnO_2) exhibits F doping.

SCAS selects the appropriate measurement conditions for the cell structure (detection sensitivity or depth resolution) and performs evaluations according to objective.

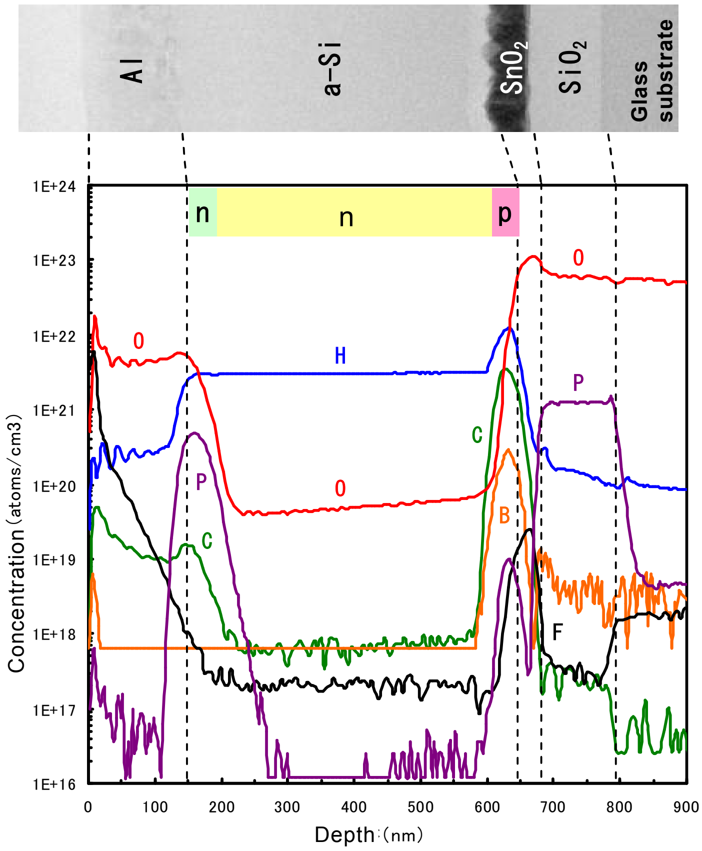

Fig.5 Results of SIMS analysis of amorphous silicon solar cell.

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