Crystal Characterization of Spherical Si Solar Cell Fabricated by Dropping Method

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Si wafers are made of Si ingots through the cutting and polishing processes where some parts of the ingot are wasted. Si spheres can be directly produced from molten Si without the cutting and polishing process. Therefore, spherical Si solar cells are expected to be low-cost cells in comparison with conventional Si solar cells, because the quantity of Si reduces. We developed a dropping method to fulfill this requirement and succeeded in the high speed production of Si spheres about 1 mm in diameter. In this thesis, we report on the crystal characterization of spherical Si solar cell.

The Si spheres were classified into two categories by surface morphology. The crystal grain size of Si sphere with rough surface is 50-100μm, while the sphere with smooth surface includes crystal grains of over 500μm size. X-ray pole figure result indicated that the Si sphere with smooth surface include the twin crystal. To investigate the crystal growth mechanism of the spheres, Si sample with various crystal sizes were observed. The result suggested that the initial crystal growth of the Si spheres with large grains involves the formation of a disk of (111) plane Si crystal. Moreover, The crystal growth mechanism for a Si sphere 1mm in diameter was proposed.

To investigate the relationship between the impurity in spherical Si solar cells and solar cell performances, the external quantum efficiency (EQE) and secondly-ion mass spectroscopy were measured. It was found that the oxygen and carbon in spherical Si solar cells influence the solar cell performance. The spherical Si solar cell performance was improved by changing air into Ar gas in the dropping area.

We investigated the relationship between the crystallinity of spherical Si solar cells and solar cell performances. From X-ray diffraction measurement results, the performances of the spherical Si solar cells are mainly dominated by the crystallinity of intragrains in the Si sphere. To inactivate the defects in the intragrains, hydrogen plasma treatment with RF plasma was performed. The increase in EQE of the long-wavelength region indicated that hydrogen plasma treatment indicated bulk passivation effect.

This thesis proposes the effectiveness of the dropping method as a new production method of Si crystals.