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Texturization of multicrystalline silicon wafers for solar cells by chemical treatment using metallic catalyst

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Abstract

A new etching method for texturing multicrystalline p-type Si wafers for solar cells was developed. In this method, we used platinum or silver particles as the catalysts, which were loaded on the wafers by means of the electroless-plating technique. After deposition of the catalysts, the wafers were etched and textured in HF solution, to which in some cases chemical oxidants were added. The solar cells (4 cm^2) manufactured from the textured wafers showed efficiency as high as 16.6%, which was about 1% (absolute) higher than that of the cells made from the wafers treated by the conventional alkaline method.

Keywords: Multicrystalline silicon; Solar cell; Texturing; Metallic catalyst

1. Introduction

Lowering surface reflectance of Si wafers by texturization is one of the most important processes for improving the efficiency of Si solar cells. In the case of single

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crystalline Si solar cells, anisotropic etching of the Si(1 0 0) plane by alkaline solutions is very effective and has been widely applied in their production [1]. As a result of the alkaline etching of the (1 0 0) plane, random pyramidal structure with low reflectivity is formed. Although the surface thus obtained has sufficiently low surface reflectance, this technique cannot be applied to multicrystalline silicon wafers, which consist of crystallites with different orientations.

In order to lower surface reflectance of multicrystalline silicon wafers, several texturing methods have been proposed, e.g., mechanical grooving [2], reactive ion etching [3–5], and acid etching [6–8]. However, mechanical grooving and reactive ion etching are not suitable for mass production, and acid etching is not sufficient for lowering the surface reflectance. Therefore, development of new methods for making lower-reflectance surfaces at low costs is still an important issue in the field of crystalline Si solar cells.

Chemical etching of silicon is effective to make controlled surface structures and has been utilized to make flat surfaces on an atomic scale [9,10]. In this paper, we present a new etching method, which uses metal particles as the catalyst, for texturizing multicrystalline Si wafers. The usefulness of the method for increasing the efficiency of solar cells is demonstrated by making 4 cm^2 devices.

2. Experimental

We used cast multicrystalline silicon wafers obtained from Bayer AG (Baysix®, 0.5–2.0 Ω cm). Surface damage caused during the wafer sawing was removed by etching in NaOH solution before the texturing procedures. In order to investigate the dependence of texturization on the crystal orientation, we used Si(1 0 0) and Si(1 1 1) wafers (Shin-Etsu Handotai Co., Ltd., 1.0–2.0 Ω cm) .

Fig. 1 represents the process sequence for the surface texturization. All processes were done at room temperature and under room light. In the first step, metallic particles, such as Ag and Pt, were deposited on the surface by the electroless-plating

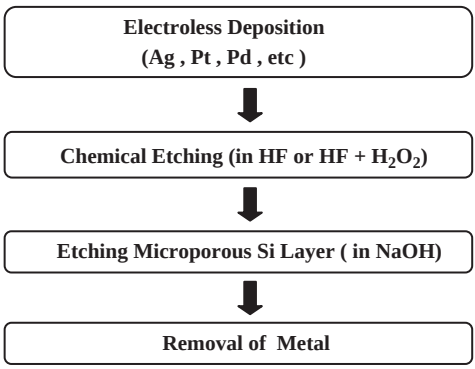

Fig. 1. Process sequence for texturization of multicrystalline Si wafers by using metal particles as catalyst.