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Optimum Design of Antireflection coating for Heterojunction Solar Cell with nc-3C-SiC:H Emitter

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1. Introduction

Silicon wafer accounts for 50% of the cost of c-Si solar cell module. Use of thinner wafers can reduce the cost of silicon solar cell. With transition to very thin wafers (<20μm), optical enhancement in silicon heterojunction (SHJ) solar cells, which has been achieved by random texturing, becomes very cumbersome. There is therefore a need to design anti-reflection (AR) coating for planar-based SHJ to reduce reflection losses. In this study simulation were carried out to optimize an antireflection coating with a dielectric material, indium tin oxide (ITO) and hydrogenated nanocrystalline cubic silicon carbide (nc-3C-SIC:H).

2. Modelling

The structure shown in Fig.1 is used for modeling of silicon solar cell using AFORS-HET, a one-dimensional device simulator. The optical generation rate was calculated taking into account interference internal multiple reflections. The complex refractive indices of all materials used in the optical simulation are obtained from ellipsometry measurements.

3. Result and discussion

Fig.2 shows the reflectance of the solar cells with different dielectric materials. The structure with MgF_2 shows lowest total reflectance, however, the difference of the total reflectance between MgF_2 and SiO_2 AR coating is small. We also calculated external quantum efficiency (EQE) spectrum of the solar cells. The EQE calculation revealed that a relatively high short circuit current density of about 38 mA/cm^2 (active area) is obtained using MgF_2 or SiO_2 AR coating. This high J_{sc} is due to the MgF_2/ITO/nc-3C-SiC:H triple AR coating because nc-3C-SiC:H shows refractive index between c-Si and ITO.

Acknowledgement

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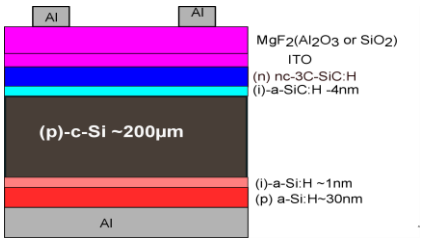

Fig.1. Structure of the SHJ with triple layer AR coating

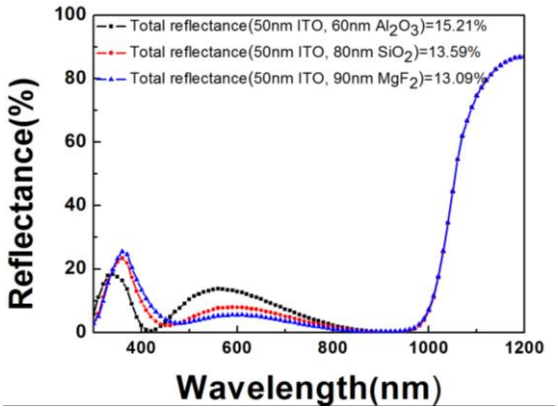

Fig.2. Simulated reflectance spectra for the three different dielectrics