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MIS-stimulated back-surface passivation of interdigitated back-contacts solar cells

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Abstract

The possibility of surface recombination losses reduction on the rear side of interdigitated back-contact solar cells by field-effect passivation is investigated. To provide field-effect passivation, an additional biased metal/insulator/semiconductor (MIS) structure is formed between n^{++} and p^{+}-doped regions. The source of the bias is the potential that appears in the solar cell under illumination. Two-dimensional (2D) numerical simulations were performed to determine the best passivation conditions. In particular, the influence of symmetric and asymmetric capture cross sections for electrons and holes at the rear side of the cell is simulated and the advantage of symmetric capture cross section for this type of passivation is discussed. Experimental and calculated data are compared for Si/SiO_2 interface.

Keywords: Solar cell; Thin film; Field effect; Capture cross section

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1. Introduction

One way to improve solar cell performance is to decrease surface recombination losses [1]. Usually this is achieved by the creation of a supplementary doped layer that forms a potential barrier for minority charge carriers on the cell back side: this effect is called back-surface field (BSF) [1,2]. However, this approach is not applicable for interdigitated back-contacts (IBC) solar cells in which both ohmic terminals are placed on the same cell side [3]. Nevertheless, back-surface recombination can strongly reduce IBC solar cells efficiency [4].

Another way to reduce the surface recombination (called field-effect passivation) consists of the creation of a surface potential barrier by charges introduction in the overlapping insulator [5] or by the creation of a biased metal/insulator/semiconductor (MIS) (MOS) structure in the near-surface region [6,7]. Field-effect passivation of the Si/SiO_2 interface by corona charging was successfully implemented for the front surface passivation of bifacial and IBC solar cells [5,8]. Surface recombination reduction by a biased MOS structure was demonstrated for the back-surface passivation of bifacial cells [6,7], for the front-surface passivation of IBC solar cells [9] and for the peripheral loss reduction of PERL silicon solar cells [10].

The possibility of back-surface passivation of IBC solar cells by a biased MIS structure is investigated in this paper. The feature of the presented approach is the absence of supplementary voltage source for MIS structure biasing because the solar cell yields this voltage itself. The influence of the symmetric and asymmetric capture cross section for the electrons and holes at the rear side of the cell is also discussed.

2. Device structure

The three structures presented in Fig. 1 were investigated. The basic structure of the analyzed devices consists of an IBC solar cell with an additional gate electrode between n^{++} and p^{+}-doped regions. The gate electrode can be isolated (a) or connected to n^{++} (b) or p^{+} (c) contacts.

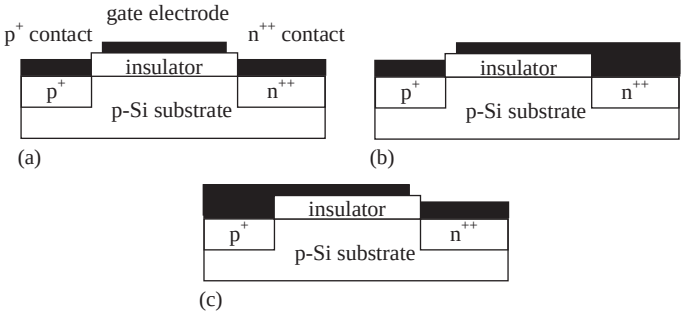

Fig. 1. Schematic design of IBC solar cell with the MIS-stimulated back-surface passivation.