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Ion-Implanted Laser-Annealed p^+ and n^+ Regions: A Potential Solution for Industrially Feasible High-Efficiency N-Type Interdigitated Back-Contact Solar Cells

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Abstract:
The main challenge for interdigitated back-contact (IBC) solar cells is to reduce the fabrication complexity, which consists of multiple high-temperature processing and patterning steps. Patterned ion implantation has been proposed to simplify the manufacture of IBC solar cells, and the annealing of boron and phosphorus implanted areas is still a problem for the application. In this study, a new method consisting of laser annealing and a subsequent low-temperature oxidation (LA&OX) has been developed to co-anneal boron implanted p^+ and phosphorus implanted n^+ regions by a single step. We found that an additional laser annealing before oxidation could improve the electrical properties of boron-implanted p^+ regions effectively; however, it has almost no effect on the phosphorus-implanted n^+ regions. An industrially feasible IBC solar cell fabrication technology has been proposed based on the patterned ion implantation and LA&OX processing. The main fabrication steps of the IBC solar cell could be reduced to ten steps, and only one high-temperature oxidation step is required. As-designed IBC cell shows a potential efficiency higher than 23% according to simulations with the experimental parameters.

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Contents

I. Introduction

N-type interdigitated back-contact (IBC) solar cells offer numerous advantages over conventional solar cells, e.g., no optical shading loss with front metal grid results in high short-circuit current density , independent optimization of surface passivation and optics at the front and large metal coverage on the rear that minimizes series resistance, ease of adopting n-type silicon, and extreme high efficiency [1]. SunPower Corporation has reported an efficiency of 24.4% on a large-area (155.1 cm^2) n-type IBC cell using production equipment [2]. Recently, an n-type IBC solar cell with an efficiency of 24.4% has been fabricated with the diffusion method at the Australian National University (ANU) [3]. However, the complex structure of IBC solar cells is often too costly for commercial production with typically two or more high-temperature diffusions and patterning steps being required. In the meantime, there are numerous disadvantages associated with multiple high-temperature processing steps, including increased processing time, high costs, increased potential for introducing contaminants, and degradation in bulk lifetime. One or more of these diffusions is performed through a diffusion mask, such as silicon dioxide, which needs to be grown at high temperatures and patterned using the photolithography method [4]. Therefore, a simplified, low-cost, and industrially feasible n-type IBC solar cell fabrication technology is highly desired.

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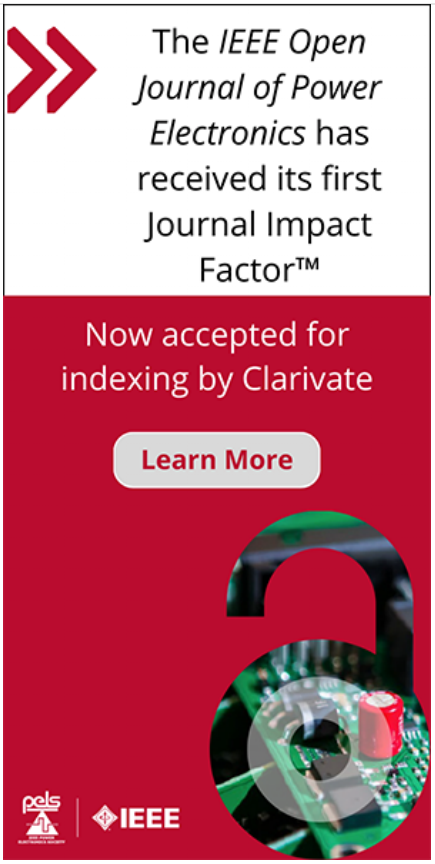

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