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Ion implantation for photovoltaic applications: Review and outlook for silicon solar cells

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Here we present a brief summary about the use of ion implantation for photovoltaic (PV) applications in the past and present. Furthermore, we highlight how ion implantation might be used in the future within the fast moving field of silicon solar cells. Ion implantation as a doping technique for silicon-based solar cells is already under investigation for several decades [1]. Nevertheless, it took more than 40 years for ion implantation to become a popular research topic for photovoltaic industry [2]. During that time, conventional Al-BSF industrial silicon solar cells featured p-type Czochralski-grown or block-casted multicrystalline base material and a POCl3 diffused emitter. Thus, the first recent studies of ion implantation in PV focus n-type emitters for p-type solar cells [2-5]. However, the already lean manufacturing process of (local) Al-BSF cells in which p+ doping is induced via the metallization process diminishes major advantages ion implantation. The situation is completely different for n-type cell designs. Here, the use of one-sided doping by ion implantation offers a process simplification, e.g. for the passivated emitter and rear, totally diffused (PERT) concept, compared to diffusion-based approaches. Especially the formation of p-type emitters by implantation of boron or boric molecules is an intensively studied topic [6-8]. Furthermore, ion-implanted PERT solar cells offer the possibility of collecting light from front and rear-side (bifaciality). Very recently bifacial factors of up to 99 % are reported, together with a simplified interconnection scheme for the production of solar cell modules [9,10]. In addition to this possible short term industrial implementation, ion implantation might become an industrial key technology for production of high efficiency silicon solar cells. Especially the combination of state of the art contact schemes, like e.g. passivating contacts [11], and back junction and back contacted (BJBC) solar cells is considered. In this context, we show the latest results of our PERT and BJBC solar cells on n-type silicon, which feature efficiencies of 21.8 % and 26.1 %, respectively.

References

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