HIGH-RATE LASER DRILLING OF SILICON WAFERS FOR PHOTOVOLTAICS

Task

High-speed laser drilling is an important processing step in the production of high-efficiency solar cells, especially in the case of emitter-wrap-through (EWT) solar cells which require ten thousand and more vias to be drilled in each cell. Given that the typical duration of a single process step on a production line for solar cells is of the order of one or two seconds, a drilling rate of 10,000 vias per second is the minimum requirement for industrial-scale production.

Method

The maximum drilling rate currently achievable with commercially available laser sources and galvanometer scanners is 4,000 vias per second. New optical concepts such as the combined use of high-performance galvanometer scanners and optical beam splitters offer a potential means of achieving the required drilling rate. This calls for laser sources with an average power output of more than hundred watts and a pulse duration in the microsecond range. A number of different system solutions were set up and compared in order to assess their suitability.

Result

Parameter studies indicate that pulse duration and pulse energy are critical factors for the efficiency of the drilling process. On the basis of experimental results, a numerical simulation of the ablation process was used to evaluate a number of different laser sources and optical concepts. Applying two coupled Jenlas IR 70 by company Jenoptik it was possible to achieve 9,600 holes/s in wafers with 200 µm thickness and 12,500 holes/s in 180 µm wafers.

Applications

The high-speed drilling process developed in this project relates specifically to a processing step in the production of EWT solar cells in which the back contacts are connected to the emitter layer through vias in the silicon. This increases the active surface area of the solar cell and hence its efficiency. The ability to drill holes of a similarly small diameter has other potential applications beyond photovoltaics, for instance in filter technology.

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