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Boron doping with fiber laser and lamp furnace heat treatment for p-a-Si:H layer for n-type solar cells

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For boron doping on n-type silicon wafer, around 1,000 °C doping temperature is required, because of the relatively low solubility of boron in a crystalline silicon comparing to the phosphorus case. Boron doping by fiber laser annealing and lamp furnace heat treatment were carried out for the uniformly deposited p-a-Si:H layer. Since the uniformly deposited p-a-Si:H layer by cluster is highly needed to be doped with high temperature heat treatment. Amorphous silicon layer absorption range for fiber laser did not match well to be directly annealed. To improve the annealing effect, we introduce additional lamp furnace heat treatment. For p-a-Si:H layer with the ratio of SiH_4:B_2H_6:H_2=30:30:120, at 200 °C, 50 W power, 0.2 Torr for 30 min. 20 mm × 20 mm size fiber laser cut wafers were activated by Q-switched fiber laser (1,064 nm) with different sets of power levels and periods, and for the lamp furnace annealing, 980 °C for 30 min heat treatment were implemented. To make the sheet resistance expectable and uniform as important processes for the p^+ layer on a polished n-type silicon wafer of (100) plane, the Q-switched fiber laser used. In consequence of comparing the results of lifetime measurement and sheet resistance relation, the fiber laser treatment showed the trade-offs between the lifetime and the sheet resistance as 100 Ω/sq. and 11.8 μs vs. 17 Ω/sq. and 8.2 μs. Diode level device was made to confirm the electrical properties of these experimental results by measuring C-V(-F), I-V(-T) characteristics. Uniform and expectable boron heavy doped layers by fiber laser and lamp furnace are not only basic and essential conditions for the n-type crystalline silicon solar cell fabrication processes, but also the controllable doping concentration and depth can be established according to the deposition conditions of layers.