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Additional Low Temperature Multiple Cycles of Annealing and Cooling after Phosphorus Diffusion to Improve Lifetime in Multicrystalline Silicon

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Previously, we have demonstrated the P gettering method to improve the phosphorus (P) gettering efficiency in multicrystalline silicon (mc-Si) wafers using multiple cycles of annealing and cooling technique at low temperature (LT) [1]. The P diffusion process is typically performed at high temperature (>800°C) which may cause the generation of dislocations during annealing, leading to the difficulty to remove impurities. In this work, we study the possibility that the proposed gettering process can be effectively applied to the inline process after P diffusion in order to improve the minority carrier lifetime. The gettering effect was evaluated by microwave photoconductance decay (micro-PCD) measurement before and after P diffusion gettering. The time-temperature profiles of the P diffusion process used and minority carrier lifetime images before and after P gettering are shown in Fig.1.

As a result, it was found that an additional LT multiple cycles revealed stronger positive effects of P gettering than continuous annealing, resulting in an increase in lifetime particularly in the good regions with low density of dislocations (Figs. 1b and 1c). The results further suggested the benefit of P gettering using multiple cycles of annealing and cooling technique, and the P diffusion combined with the proposed gettering process is concluded to be feasible to improve the electrical properties of mc-Si for solar cells.

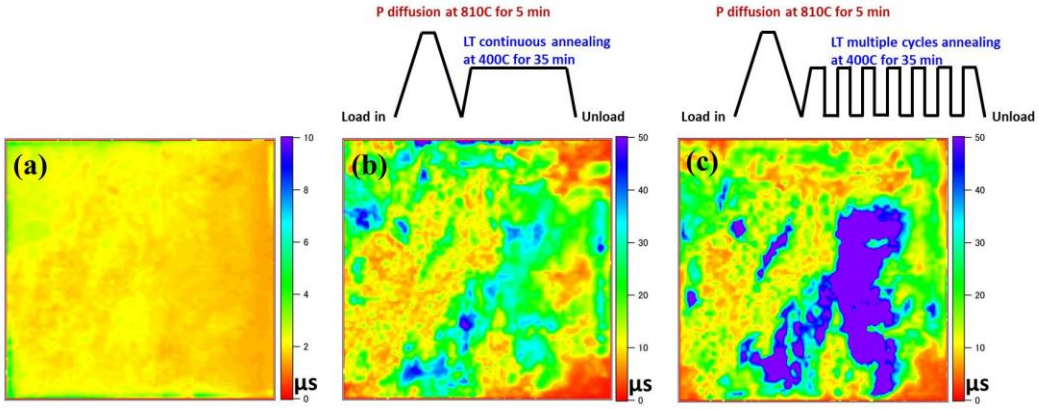

Fig. 1. Distribution of minority carrier lifetime of passivated mc-Si wafers (a) before gettering, (b) after P diffusion at 810°C for 5 min followed by LT continuous annealing at 400°C for 35 min, and (c) after P diffusion at 810°C for 5 min followed by LT multiple cycles annealing at 400°C for 35 min in total.

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Ref. [1]. S. Joonwichien et al., Energy Procedia (2014) (To be published).