Dear Editor,

We like to express our appreciation to the reviewers for their comments. We are resubmitting the revised version of the paper number SM–2018–103. We have studied the comments of the reviewer carefully, and have changed the text according to the comments they have listed. Below we refer to each of the reviewers comments.

Response to Reviewer #1

Comment 1. *Concentration of recombination centers such as B-O, Fe-B is more than* 10^6 *times smaller than that of matrix atoms. That might reduce the probability of ultrasound-induced tuning of recombination properties of such defects*

Reply:

The point defects can effectively interact with ultrasound wave regardless of their low concentration. In our opinion, the striking examples are the experimental methods, which are based on analyse of anomalies in speed and attenuation of ultrasound wave and allow to investigate the native and impurity defects [1–5]. For instance, the concentration of vacations in the silicon investigated by ultrasonic experiments has been down to $10^{13} - 10^{15}\text{cm}^3$ [3, 5]. Besides, it was reported about acoustically induced transformation of the antisite defect in GaAs [6], dissociation of the Fe–B pairs in silicon [7], modification of the emission rate from the donors in Si [8], variation of the Na density in Si–SiO_2 system [9], annealing of the radiative defects [10, 11] *etc.* In all cases the defect quantity was paltry in comparison with those of matrix atoms.

At the same time, the recombination centers with low concentration lead to dramatically change of carrier lifetime. The ultrasound–induced tuning of solar cell parameters is defined by relative change of recombination properties of such defect in the first place and by their concentration in the second place. But Reviewer is right absolutely and the enlarge of acoustically–active defect concentration have to increase the absolute value of acoustically induced effects.

Comment 2. *The reason of the degradation is explained by the acoustically induced increase in the carrier capture coefficient of point or extended defects. More detailed discussion of this point would be interesting as to whether it means ultrasound–induced transformation of the defects or why the change happened.*

Reply: The mechanisms of the acoustically induced increase in the carrier capture coefficient for point defects and extended defects are generally different.

As was mentioned above the ultrasound can be a tool of the point defect transformation and study. The acousto–defect interaction depends on a strain which is deals with the disturbance of lattice periodicity. In fact, the displacement (with respect to surrounding) of impurity atoms, which produce tensile stress, is opposite to the displacement of defect with compressive stress [12, 13]. In our assumption, the ultrasound loading leads to the increase of the average

distance r between the non–equivalent component of a defect complex. According to [14, 15], the carrier capture cross section is proportional to r^2. Therefore the acoustically induced increase in the carrier capture coefficient of point defects is observed. The more detailed information is presented in items 3.2 and 3.3.

Dislocations are generally held responsible as a possible source of shunt resistance [16–18]. The impedance value is inversely proportional to the surface area of the dislocation [19, 20]. In our opinion, the extended defect oscillation under the influence of an applied ultrasound stress leads to enlarge of its effective surface. As a result, the dislocation contribution to the recombination current increases and shunt resistance decreases. The acoustically induced R_{sh} decrease was observed experimentally. The more detailed information is presented in item 3.4.

Comment 3. *How the surface of Si has been treated before the study of the influence of ultrasound*

Reply: The special surface treatment after the standard solar cell manufacturing was not carried out. The piezoelectric transducer was attached to a full–area Al back contact. The acoustic contact was made by using the gluten "BF–6". The gluten can be dissolved by an ethanol and the metal contact surface have been remaining undamaged after transducer detachment.

More detailed information about ultrasound loading was added to item 2.2.

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