Transillumination Photoluminescence

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Abstract - **This paper deal with an innovated testing of photoluminescence method. This method consists in backlighting of solar cells with high wattage halogen lamp. We would like to present what kinds of defects are detectable with this method and how clear we can see these defects. And not least we are comparing classic and new transillumination photoluminescence methods.**

Keywords – **Solar cell, diagnostic, photoluminescence, transillumination**

I. Introduction

A Photoluminescence

Photoluminescence is a kind of luminescence evoked by energy of incident electromagnetic radiation. According to Stoke's law have an excited radiation of light always higher value of wave length (lower of energy value) than exciting radiation. That is why the luminescence can be only rarely evocate by the visible radiation. Usually it is necessary to use an ultraviolet or X-ray radiation. Photoluminescence spectroscopy is being used to investigate defects and localized band tail states within the band gap of silicon wafers. From the comparison of band-edge photoluminescence intensity and minority carrier lifetime, we confirmed that low photoluminescence intensity regions corresponded to short lifetime regions.

B Transillumination photoluminescence

The method of transillumination photoluminescence is getting on from same presumptions and laws like standard method photoluminescence described in previous chapter. Difference is only in placing source of short-wave exciting light radiation. At classic method photoluminescence the source is set on same the side solar cell like CCD camera. On the other hand at transmission photoluminescence is the source set on the opposite side solar cell than is the CCD camera. Supposed advantage of this method is that we might see more distinctly structure respectively defects hidden in greater depth from front side of solar cell.

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II. Experimental Part

A. Description of measuring workplace

On the Figure 1 there is a scheme of measuring workplace of experimental photoluminescence diagnostic method with transillumination lighting at look to the internal part. Measuring box, which is exploited also by others diagnostic methods, was necessary to modify for purposes of metering by means of transillumination lighting. Appearance to that in special illuminant box with matt surface glass owing to halogen lamps happens at illumination to temperature increase, to be necessary this space ventilation and that is why into the side of structure measuring box had to be bored two vents. First vent with diameter 50 mm is determined to supply ventilating into box and second vent with diameter 40 mm for drain off hot air out of box. Vents farther was necessary equip with bushings which make for gripping ventilating tubing plus eventually to obstruction of these vents.

B. Result of measurement

On the figures 2, 3, 4 and 5, 6, 7 are step by step captured three solar cells by methods photoluminescence and transillumination photoluminescence so that couple forms always same cell measured by those methods. On the Figures 5, 6 and 7, captured through the usage of classical method photoluminescence, there are visible bright dots guiding spot caused by inhomogeneity of material. On the Figure 4 there is in middle part good visible defect inhomogeneity diffusive layer. On Figures 2, 3 and 4 are same three cells measured using by transillumination photoluminescence. There are obviously visible surface defects, grid of backside contacts, mild inhomogeneity of silicon wafer and diamond-shaped phenomenon in the middle which come up in some our measuring solar cells and which come through caused by either strange reflection from matt surface glass or by structure in use source of light. This method thus relatively well discovers surface defects silicon solar cells, indeed there are not expressive visible inner defects such as for example swirl defect. Some account swirl defect placed in the middle of measured solar cell sample A, but isn't too objective. Well visible is there back grid of solar cell consist of silver (Ag) with addition aluminum (Al). To be possible to see inner defects it requirements through functioning light source change depth of penetrating radiation of light into solar cell. Cells are manufactured in thickness to the 300 μm. Ideal depth of penetrating lights for detection inner defects would be about 100 – 150 μm.

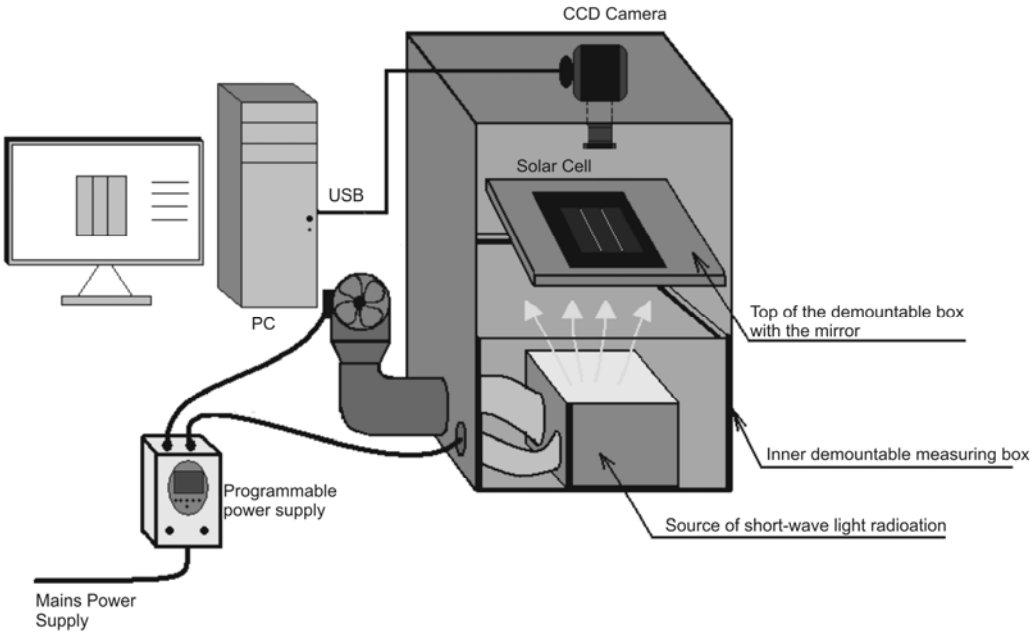

Figure 1: Scheme of measuring workplace

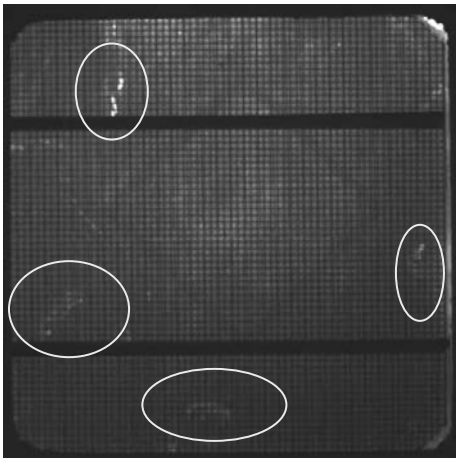

Figure 2: Transillumination PL Sample A

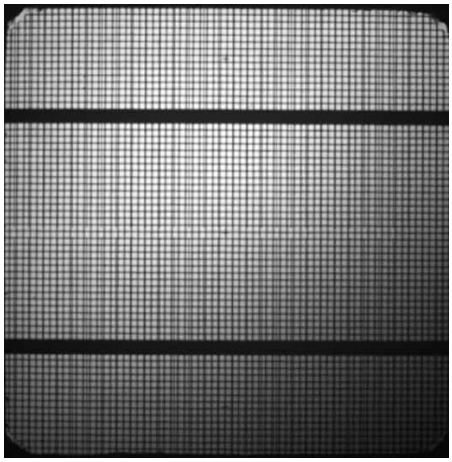

Figure 3: Transillumination PL Sample B

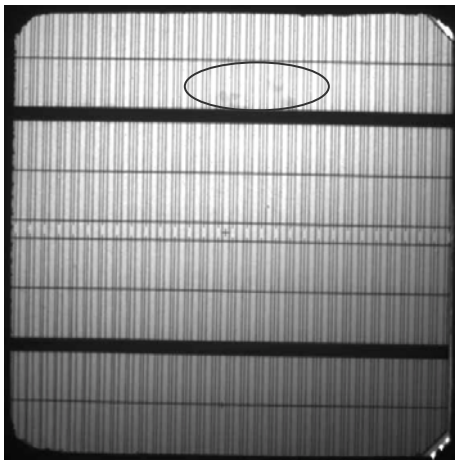

Figure 4: Transillumination PL Sample C

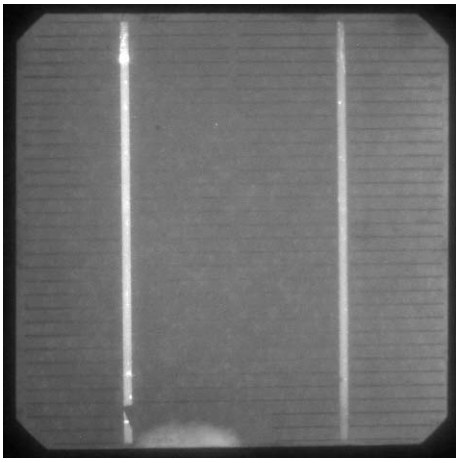

Figure 5: Photoluminescence Sample A

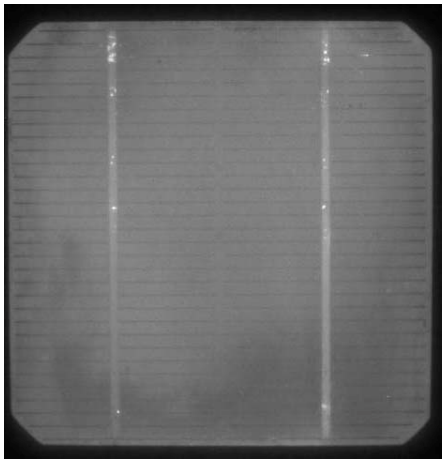

Figure 6: Photoluminescence Sample B

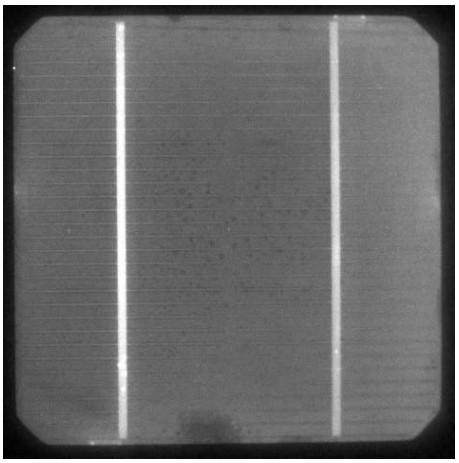

Figure 7: Photoluminescence Sample C

III. CONCLUSION

This method discovers relatively well surface defects of silicon solar cells however there are not expressive visible inner defects such as for example the swirl defect. Ours expectation unfortunately didn't acknowledge. To be possible to see inner defects, it requirements through functioning light source change depth of penetrating radiation of light into solar cell. The other problem was that ours source of ultra-violet light radiates in infra-red spectrum, too. This infrared radiation passes through solar cell block out infra-red light emitted by the photoluminescence. To future development will be necessary this infra-red radiation filtered off or provide such source of light, which would in this spectrum not radiate.

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