Designing a low cost camera to analyse defects in photovoltaic cells with the forward and reverse bias electroluminescence method

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Background

The department of solar energy in the Faculty of Electrical Engineering and Communication (FEEC) in the Brno University of Technology (BUT) researches the detection of defects in solar cells using the electroluminescence method. The current setup for this method is shown in figure 2 below.

Electroluminescence

This method is based on the **conversion of current into infrared light** that is visible through a camera which visualises the defects depending on the **different intensities** of emitted light. The electroluminescence method can be performed in both **forward** and **reverse bias** with each version providing different results as shown in figure 1 below.

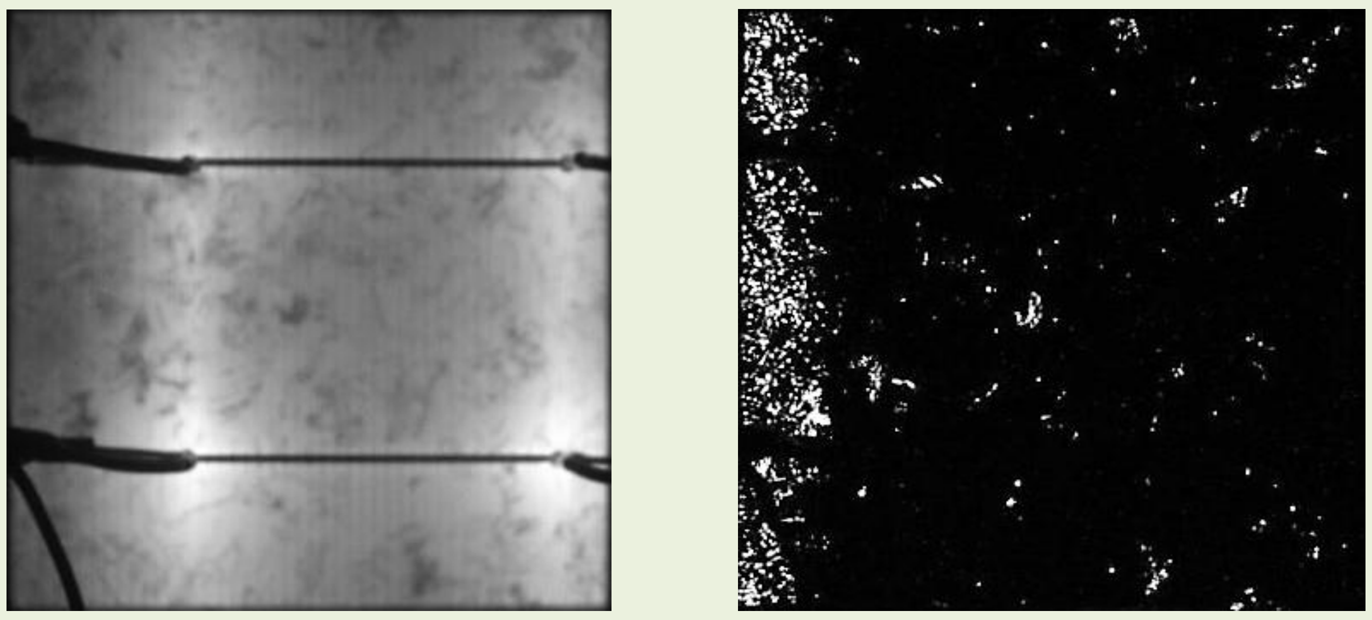

Figure 1: Forward (left) and reverse (right) bias electroluminescence photo of a polycrystalline silicon solar cell

Problem

This Master's Thesis focusses on the **comparison** of the forward and reverse bias electroluminescence method to detect the different defects in solar cells. The current setup, that can be seen in figure 2, uses an expensive astronomy CCD camera (circled yellow) that is not robust enough to withstand the handling of students. Meanwhile a **cheap alternative camera** is developed and built for students to experiment with.

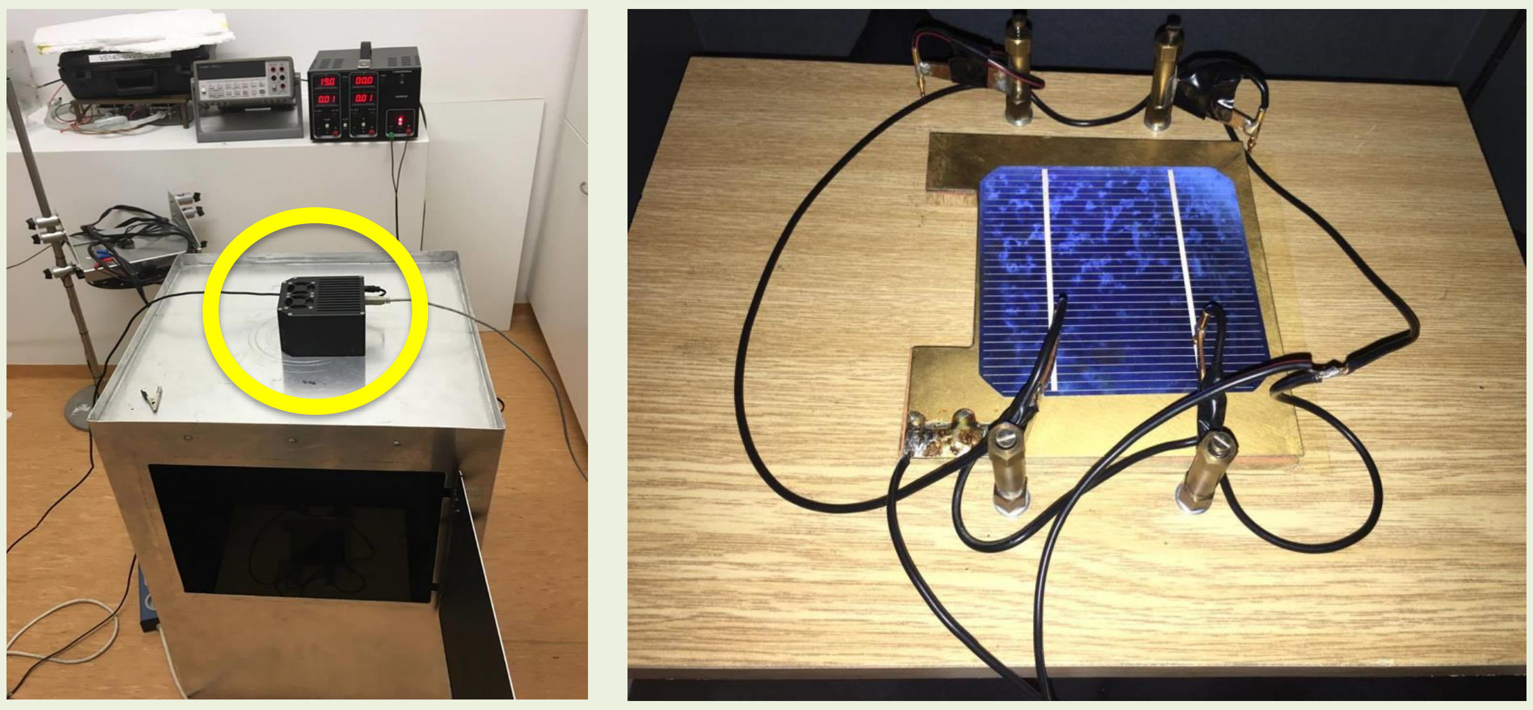

Figure 2: Current setup for the electroluminescence method

Method

First, based on a **literature study** an overview of the currently known defects in solar cells caused by **silicon-growth techniques** and **manufacturing processes** is made. Secondly, the **forward** and **reverse bias** electroluminescence techniques are compared. Thirdly, the already well-established **CCD** chips are compared with the upcoming **CMOS** technology to define the optimal option. Finally, the **conversion** of a commercial camera, identified by a small market study, into an infrared camera is realized.

Conclusion

The **forward bias** electroluminescence proves to be **valuable** for both **monocrystalline** and **polycrystalline** silicon solar cells as it can visualise most of the known defects. The **reverse bias** electroluminescence on the other hand proves to be **unreliable** for **monocrystalline** silicon solar cells as it's unable to detect silicon-growth defects but it proves to be **equally effective** for **polycrystalline** silicon solar cells. Although this method provides the same information as its forward bias counterpart, the **sharpness** of the reverse bias images is **considerably higher** which makes it the optimal detection method for polycrystalline silicon solar cells.

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