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Analyses of Defects in Flexible Silicon Photovoltaic Modules via Thermal Imaging and Electroluminescence

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Abstract : It is known that for industrial applications using solar panel constructed from silicon solar cells require high-efficiency performance. One of the main problems in solar panels is different mechanical and structural defects, causing the decrease of generated power. To analyse defects in solar cells, various techniques are used. However, the thermal imaging is fast and simple method for locating defects. The main goal of this work was to analyze defects in constructed flexible silicon photovoltaic modules via thermal imaging and electroluminescence method. This work is realized for the GEKON project (No. GEKON2/O4/268473/23/2016) sponsored by The National Centre for Research and Development and The National Fund for Environmental Protection and Water Management. Thermal behavior was observed using thermographic camera (VIGOcam v50, VIGO System S.A, Poland) using a DC conventional source. Electroluminescence was observed by Steinbeis Center Photovoltaics (Stuttgart, Germany) equipped with a camera, in which there is a Si-CCD, 16 Mpix detector Kodak KAF-16803type. The camera has a typical spectral response in the range 350 - 1100 nm with a maximum QE of 60 % at 550 nm. In our work commercial silicon solar cells with the size 156 × 156 mm were cut for nine parts (called single solar cells) and used to create photovoltaic modules with the size of 160 × 70 cm (containing about 80 single solar cells). Flexible silicon photovoltaic modules on polyamides or polyester fabric were constructed and investigated taking into consideration anomalies on the surface of modules. Thermal imaging provided evidence of visible voltage-activated conduction. In electro-luminescence images, two regions are noticeable: darker, where solar cell is inactive and brighter corresponding with correctly working photovoltaic cells. The electroluminescence method is non-destructive and gives greater resolution of images thereby allowing a more precise evaluation of microcracks of solar cell after lamination process. Our study showed good correlations between defects observed by thermal imaging and electroluminescence. Finally, we can conclude that the thermographic examination of large scale photovoltaic modules allows us the fast, simple and inexpensive localization of defects at the single solar cells and modules. Moreover, thermographic camera was also useful to detection electrical interconnection between single solar cells.

Keywords : electro-luminescence, flexible devices, silicon solar cells, thermal imaging
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