UTILIZATION OF NOISE CHARACTERISTIC FOR QUALITY CHECK OF SOLAR CELLS

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ABSTRACT

Testing methods, originally developed for luminescent diodes and other semiconductor devices was applied to an ensambles of solar cells. Quality of the devices is assessed according to forward and reverse V-I characteristic and noise voltage spectral density.

1 INTRODUCTION

To characterize technology of devices preparation we measured V-I characteristic and the noise spectral density in forward and reverse direction, mainly at room temperature. The purpose of the experimental study is to characterize duality and make an attempt to predict reliability of these devices. The noise voltage spectral density in the low injection region versus the forward current is supposed to follow the quadratic law and the frequency dependence is 1/f like with a certain component of g-r and burst noise. In this region these noise components are present due to defects in the sample structure. In the high injection region the noise is generated in the contacts, which allows the contacts quality to by assessed.

2 SOLAR CELLS

Solar cells are made of special materials called semiconductors such as silicon, which is currently the most commonly used. Basically, when light strikes the cell, a certain portion of it is absorbed within the semiconductor material. This means that the energy of the absorbed light is transferred to the semiconductor. The energy knocks electrons loose, allowing them to flow freely. Solar cells also all have one or more electric fields that act to force electrons freed by light absorption to flow in a certain direction. This flow of electrons is a current, and by placing metal contacts on the top and bottom of the solar cell, we can draw that current off to use externally. This current, together with the cell's voltage, defines the power that the solar cell can produce.

2.1 SAMPLES DESCRIPTION

Solar cells for measurement was granted by the producer the firm Solartec, s.r.o.. Solar cells are circular contour ∅101,0 mm and thickness 360 micrometers, made of monocrystalline silicon with $n^{+}pp^{++}$ PESC type structure which were fabricated on p-type CZ Silicon wafers. We were granted one set of solar cell with ten samples.

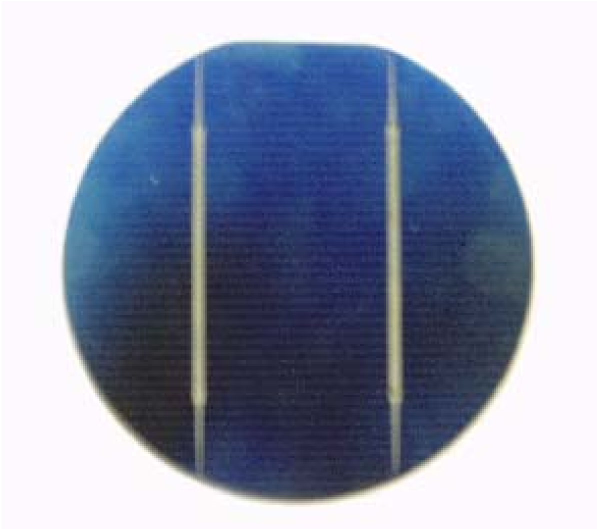

Fig. 1: *Solar cell No. 301*

3 I-V CURVES

I-V curves generally of several regions. The regions are: a) *linear,* corresponding to leakage current, b) *exponential*, corresponding to generation-recombination current, c) *exponential,* corresponding to diffusion current, d) region of high injection current, e) region, where the effect of series resistance is dominant.

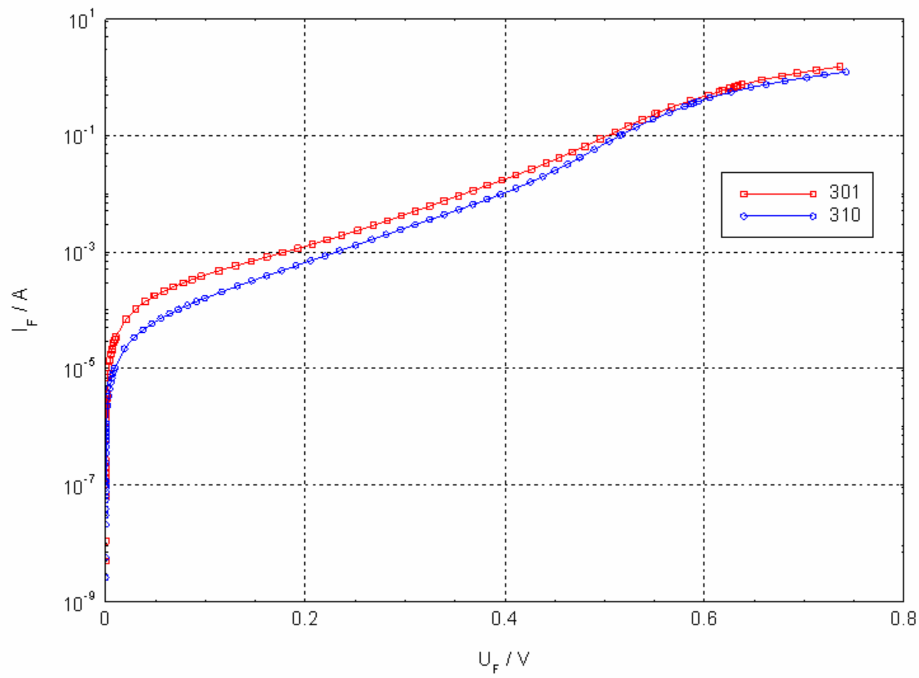

Fig. 2: *I-V characteristic for samples No. 301 and 310 in forward bias direction*

All these regions can be found in our solar cells, though some of them can be hidden or overlapped. In Fig. 2, where we compare characteristics of samples 301 and 310, all regions are shown.

4 ANALYSES OF NOISE PROPERTIES OF SOLAR CELLS

Experimental study of the solar cell properties is faced with problems related to giant surface area which is of a order of 100 cm squared. The capacity of the PN junction is of a order of several microfarads.

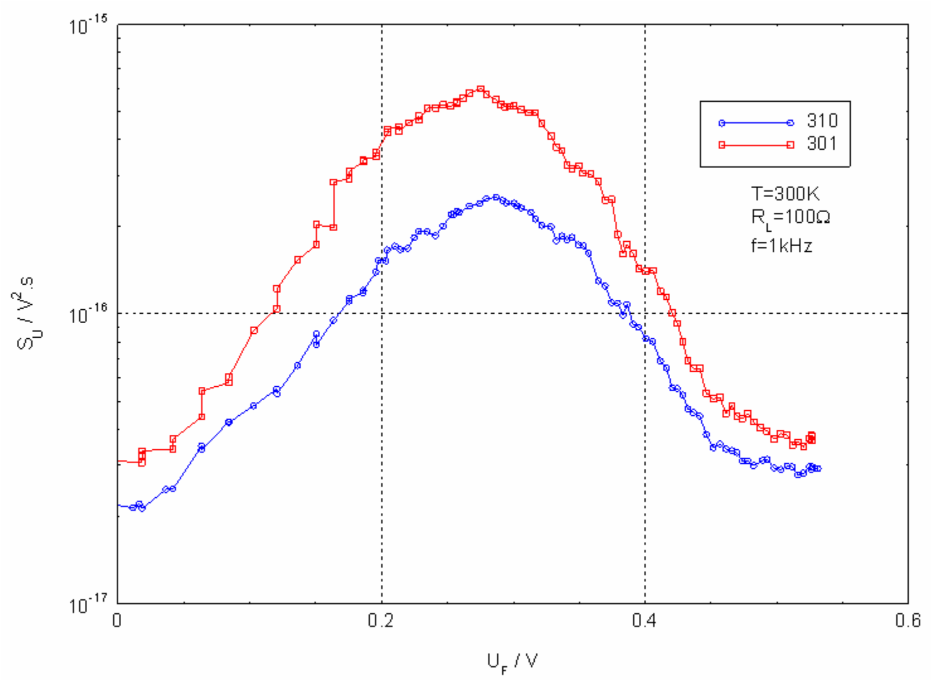

Fig. 3: *The noise spectral density as a function of forward voltage for samples No. 301 and 310*

Fig. 3 shows the noise spectral density versus the forward voltage, with the load resistance being 100 Ω. The noise voltage extreme occurs at a DC voltage at which the junction dynamic resistance equals approximately the load resistance. In this region the excess noise spectral density passes from a quadratic law in linear law region. The sample 301 has lower noise spectral density than sample 310, because the current for sample 301 is higher than current for sample 310 as can see in Fig. 2.

All samples exhibit 1/f noise, which is dependent on mobility of carriers. In Fig. 4 we can see this noise and for sample 301 is 1/f noise higher than for sample 310 again. These noises are measuring with the voltage which is corresponding with the maximum noise. For sample 301 is the voltage value 0,291 V, for sample 310 is the voltage value 0,284 V.

Defects in pn junctions are sources of burst noise. Some samples, for example number 310 exhibits noise in forward direction. Temperature dependencies of time between two successive pulses are generally used to determine the parameters of this noise sources.

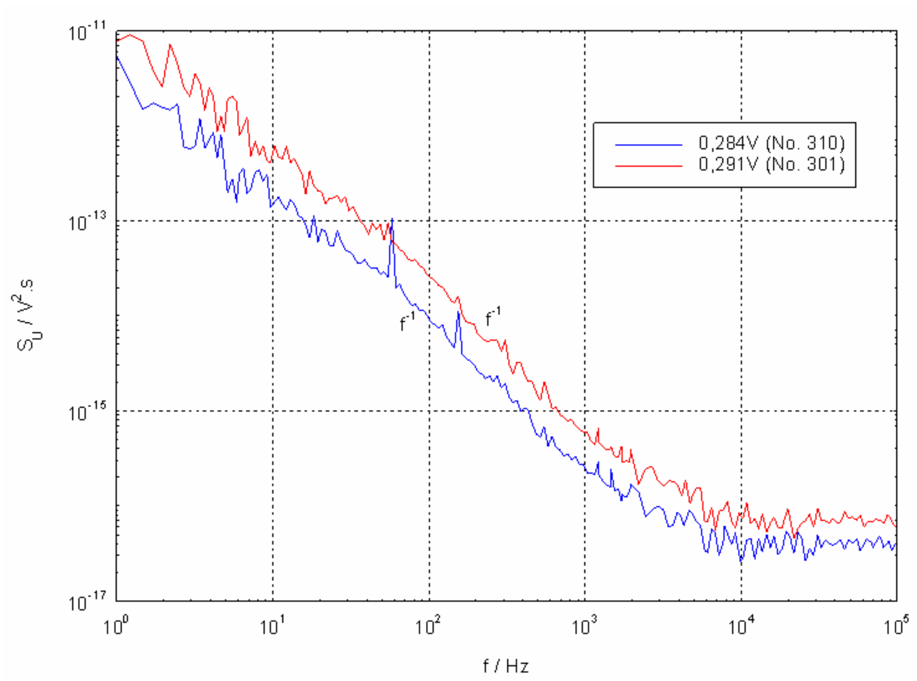

Fig. 4: *The noise spectral density versus frequency for samples No. 301 and 310*

5 CONCLUSIONS

Characteristic of solar cells can be measured by various methods. The forward I-V characteristic is divided into three regions, where different transport mechanisms are dominant – very low injection, generation-recombination and diffusion regions and in the region where PN junction resistance is dominant. The noise measurement of the solar cells can be used as a sensitive assessment tool and there is a potential interest for lifetime evaluation.

Photovoltaic system can be used as a source of electric energy in family houses and complement supplies of electric energy to the electric power net.

ACKNOWLEDGEMENTS

This research has been supported by project of GACR No.102/04/0142 and project MZP VaV/300/01/03.

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