Comparing Contact Technologies by 1/f Noise in Photovoltaic Cells

Jiří Vaněk, TU Brno+, Jiří Kazele, TU Brno+, Zdeněk Chobola, TU Brno++

+Technical University of Brno, Faculty of Electrical Engineering, Department of Electrical and Electronic Technology
++ Faculty of Civil Engineering, Dept. of Physics

Research and development concerning new production technology of photovoltaic cells contact are key activities in this paper. We have compared this new technology with old technology by using I-V characteristic and noise spectroscopy.

1. Introduction

We have studied a total of 5 solar cells made by new contact technology and 5 solar cells made by old contact technology. The old technology “Alpha technology” is making contact by sputtering copper layer after PN junction making on both sides on silicon wafers. The P++ side of silicon photovoltaic cells is full filed of slim copper layer plate and the other side is created of contact stripes and fingers. For the best contacting and the surface copper coating is used slim layer alloy of tin. This high technology is very sophisticated and expensive. The new technology “Beta technology” is making contact by screen printing silver alloy pasta after PN junction making and bake a coating in oven. The P++ side of silicon solar cell is not full filed of the contact layer but is created by grid of stripes. This technology is no so expensive as alpha technology. As a characterizations tools we use U-I and noise characteristic [1,2].

2. Experimental Techniques

All the Si solar cell samples are of large area (10*10 cm) and thickness 360 micrometers, made of mono-crystalline Si with n⁺pp++ type structure which were fabricated on p-type CZ silicon wafers and solar cell are only variant by alfa of beta contact technology. The samples were mounted in a holder at room temperature (300K). Then we have measured I-V characteristic and made noise spectroscopy. We have compared the samples which have the same photovoltaic characteristic e.g. samples α33V2 and β33V2. Then we have cut the sample α32V2-2 and β33V2-2 to the pieces of small area (1*1 cm) and made the measurement again with higher current density.

3. Experimental results and discussion

The comparing of I-V characteristic in high current area of sample no. α32V2-2 and β33V2-2 is shown in Fig. 1.

The deflection of the I-V characteristics from slope is bigger by β33V2-2 at higher voltages makes it possible to determine the contact series resistance, whose value is $R_s = 0.072 \, \Omega$ while resistance of sample α32V2-2 is $R_s = 0.049 \, \Omega$.

In Fig.2 noise voltage spectral density $S_u$, versus applied forward voltage plots are shown for specimen α32V2-2. The load resistance was $R_L=100 \, \Omega$ and the pass band central frequency was $f=1 \, \text{kHz}$. On these figure is comparing of $S_u$ noise small sample α32V2-2 by connecting by holder and by soldering joint. We can observe not well adjacent beta-type contact to ladders, which is noticeable from marked increasing of excess noise component at unsoldering joint for voltage area greater than 0.5V.

34-1
Fig. 1. I-V characteristic in high current area of sample α32V2-2 and β33V2-2

Fig. 2. Comparing of Su noise 100 mm² sample α32V2-2 by connecting by holder and by soldering joint
Fig. 3 The noise spectral density versus frequency for sample No. α32V2

In fig. 3 is noise voltage spectral density $S_U$ versus frequency dependence of $\alpha 32V$. The noise voltage is taken on load resistance $R_L=100\,\Omega$. Voltage $U_f=0.74$ V is in the put in the effect contact noise area. From the picture is clear, that the excess noise component $1/f$ is prevailing to the frequency $10^4$Hz, which is for higher frequency than $10^4$Hz masking by thermal noise.

Fig. 4. Comparing of $S_u$ noise small sample $\alpha 32V2-2$ and $\beta 33V2-2$
In Fig.4 noise voltage spectral density $S_U$, versus applied forward voltage plots are shown for specimen $\alpha$32V2-2 and $\beta$33V2-2. The load resistance was $R_L=100 \ \Omega$ and the pass band central frequency was $f=1 \ kHz$. On these figure is comparing of $S_u$ noise small sample $\alpha$ technology and $\beta$ technology. We can observe increasing of excess noise component at beta type solar cell.

4. Conclusion
We have studied collection of silicon solar cells with contact $\alpha$ and $\beta$ type. Experimental results obtained by once from I-V characteristic so also monitoring of spectral voltage noise density curves point to higher qualities of alpha technology.

References