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Photovoltaic and new trends

This article deals with the latest information from the field of photovoltaic, photovoltaic cells and its efficiency and materials used for their production.

Keywords: photovoltaic cells, materials, efficiency

I. INTRODUCTION

From the articles cited in this text it is clear, that the re-search focuses on efficiency improvement, used of new materials and thins [2], [3], [6], [9].

The progress of development of efficiency goes above 20 % for industrial production. Therefore it is necessary to briefly sum knowledge from this field.

II. NEW MATERIALS

In German joint project [1] a comparison of different space solar power generator technologies was made. It can be seen, that different technologies due to the efficiency of the difference solar cell technologies differs. The highest efficiency has typical GaAs triple junction solar cell comprised of 150 µm rigid substrate [1].

TABLE I

Typical parameters of solar power generators with different solar cell types

SC type	η_{BOL} [%]	W/m²	3.5 kg/m² W/kg	0.5 kg/m² W/kg
Si	16.8	90	23.7	-
GaAs	28.0	185	42.4	-
CIGSe	10.0	65	18.2	118
	15.0	104	29.1	189
	20.0	143	39.9	259

In [2], over 15% efficiencies were demonstrated from 17-cell-integrated submodules on these substrates. The highest submodule efficiency demonstrated in this study was 15,9%.[2]. (Fig. 1)

On the other hand, efficiency 19,6 % was achieved on 148 cm^2 amorphous/crystalline double heterojunction solar cells. This change in efficiency was achieved by transfer of old solar cell fabrication process to an integrated JUSUNG large area cell. Optimization of each technological step has led to the fabrication of large area devices.

Similar and larger efficiency was achieved for cells in industrial production [3] The calculations have shown that it is possible to reach an efficiency of around 20% on boron-doped oxygen-contaminated silicon with an industrially feasible cell structure.

Figure 1 CIGS modul [2]

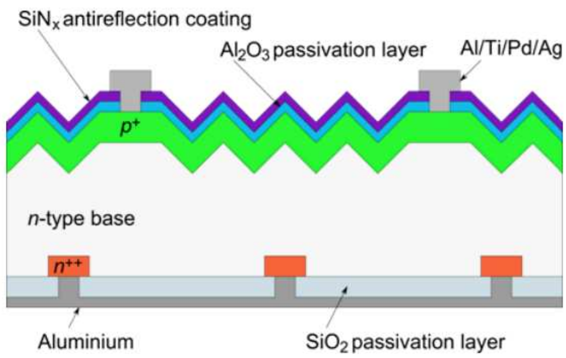

Figure 2 Cell structure with boron-diffused front emitter [16]

Results of the above mentioned boron-diffused front junction are in table 2:

TABLE II

Results of cells with boron-diffused front junction [16]

Rear structure	V_{oc} [mV]	J_{sc} [mA/cm^2]	*FF* [%]	η [%]
Thermal oxide + locally diffused P-BSF	705	41.1	82.5	23.9*
New PassDop layer + laser-fired P-BSF	701	39.8	80.1	22.4*
Full-area P-BSF + printed front contacts	654	38.7	80.8	20.5

Other vision was presented in article with title: „HOT CARRIER SOLAR CELLS: CHALLENGES AND RECENT PROGRESS“ [7]

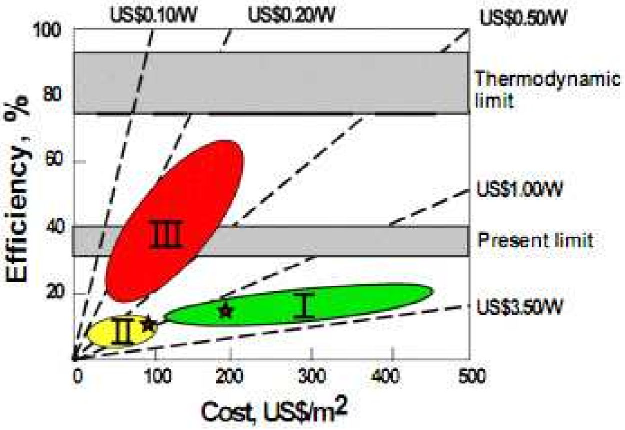

Figure 3 Cost/efficiency regions for three generations of PV technology [7]

On the basis of analysis given in [7], hot carrier cells are arguably the highest efficiency photovoltaic concept yet suggested. [7], [8]

III. TIN FILMS

To improve transformation efficiency, could be used films. From the research made in [13], no significant changes were proved. Efficiency of transformation and efficiency of the panel depends on the particles size used in films. Example of efficiency is shown in the following table:

TABLE III
Characterized parameter of obtained GaAs PV cell measured before and after par/ticle coating [13]

	Without particle coating			With particle coating			
Particle size (nm)	J_{SC} (mA/cm$_2$)	V_{OC} (V)	η_{ARC} (%)	J_{SC} (mA/cm$_2$)	V_{OC} (V)	η_{ARC} (%)	$\Delta\eta$ (%)
100	25.15	0.931	17.22	25.91	0.939	18.44	7.08
200	23.66	0.894	15.40	24.92	0.894	16.28	5.71
400	24.76	0.94	16.76	23.03	0.942	16.25	-0.30

As it can be seen from table 3, coating increased its relative efficiency for the diameters of 100 and 200 nm, while 400-nm particles slightly decreased efficiency.

One of the possibility i salso use thin-film polycrystalline silicon solar cells with low intragrain defect density made via laser crystallisation and epitaxial growth. This technology combines the cost benefit of thin-films and the quality potential of crystalline Si technolog [14]. Efficiency is low, about 5,4 - 8 %.

IV. APPLICATIONS

Methods of connection and protection of photovoltaic power plants are well known, but in [15] was described implementation of high penetration of photovoltaic power plant into micro grid.

Figure 4: Photovoltaic power plant in La Ola [15]

After interconnection requirements study it was necessary to customize power controllers

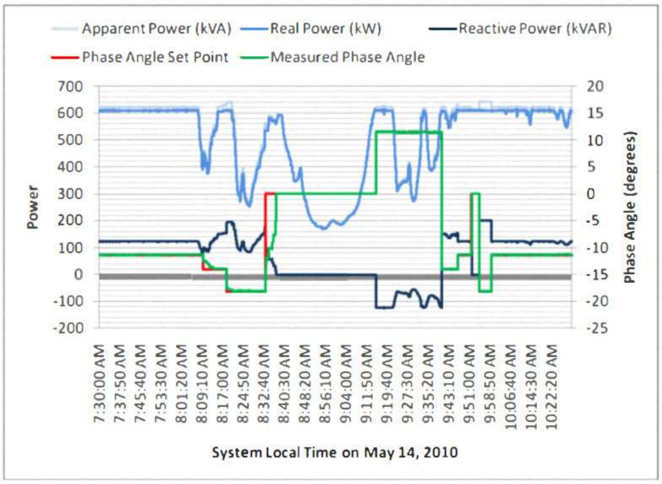

Figure 5: PV plant response to change in power factor set point [15]

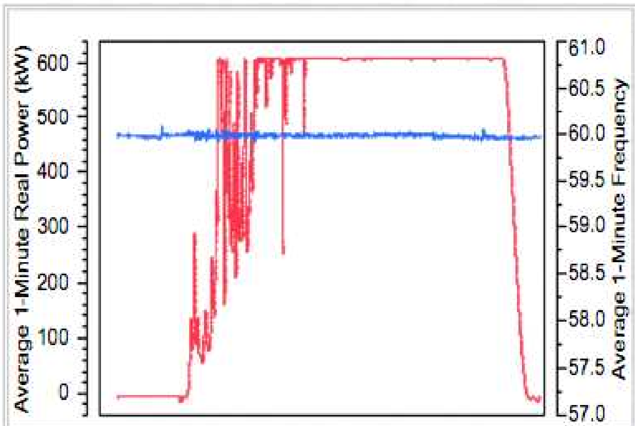

Figure 6: PV plant power output (red) and grid frequency (blue) on April 11, 2010 [15]

From the customisation and IRS it is clear, that successful work was done.

V. CONCLUSION

From the above given words it is clear, that use of new materials and research of new types of cells go towards new and high efficient materials. The highest priority for all is to use the most efficient materials for conversion of sun energy to electric energy. 3rd generation of photovoltaic cells and improved (more than 20 % efficiency) photovoltaic cells help us to convert the energy more efficient.

From research activities of other research institutes is known, that were developed new methods for detection of detects.

On the other hands it is necessary to focus also on interconnection of large sources into small grids. Some possibilities and applications were described.

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