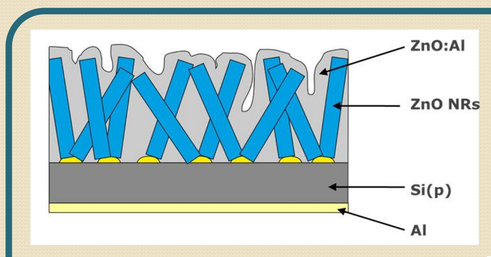
Struktury fotowoltaiczne Si/ZnO – Nowe rozwiązania

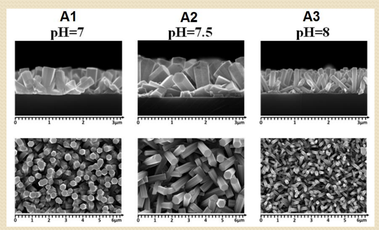
R. Pietruszka[1], B. S. Witkowski[1], S. Gieraltowska[1], L. Wachnicki[1], E. Zielony[2], P. Bieganski[2], E. Płaczek-Popko[2], M. Godlewski[1,3]

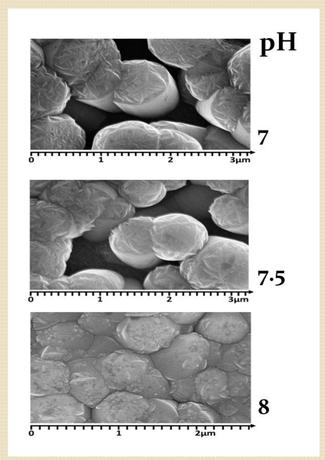
[1]Institute of Physics, Polish Academy of Sciences, Warsaw, Poland
[2]Faculty of Fundamental Problems of Technology, Wroclaw University of Technology, Wroclaw, Poland
[3]Department of Mathematics and Natural Sciences College of Science, Cardinal Stefan Wyszynski University, Warsaw, Poland

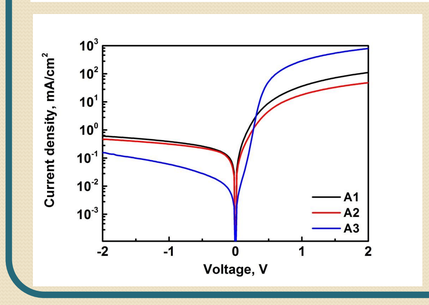
Aim of work

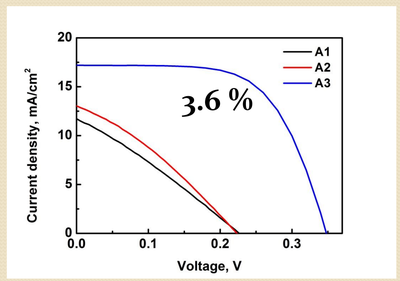
Zinc oxide (ZnO) films and nanorods are used in photovoltaic devices (PV), both as an n-type partner to p-type substrates and (on top) as a transparent electrode. We search for the optimal electrical properties of n-ZnO nanorods to achieve the best photovoltaic response of such PV structures.



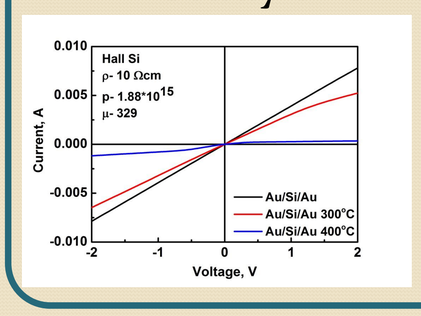


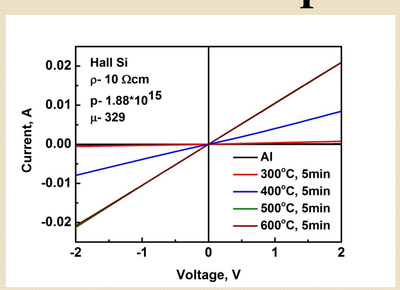


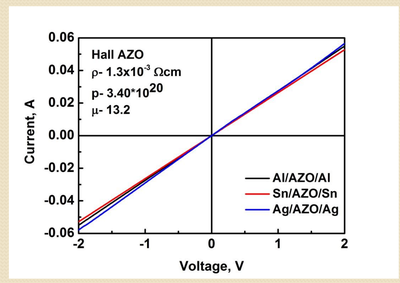


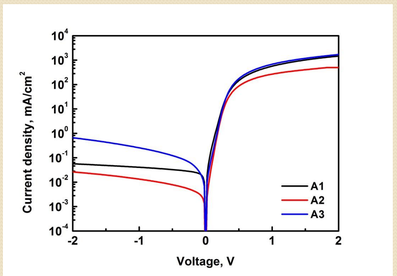


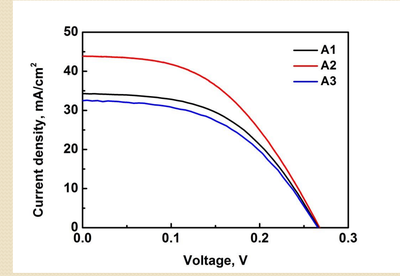
Study of ohmic contacts to p-Si and n-ZnO:Al





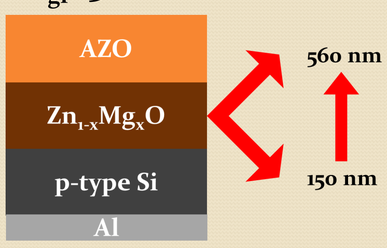


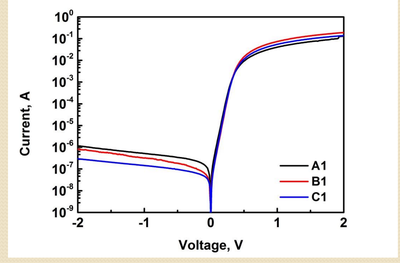


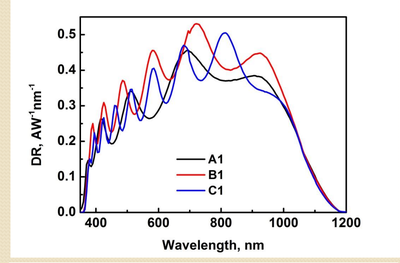


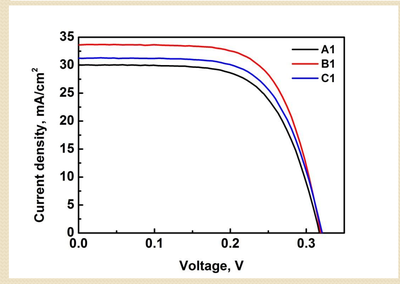
No.	d [nm]	I_{sc} [mA/cm²]	V_{oc} [V]	FF [%]	Eff. [%]
C1	600	34	0.27	50	4.9
C2	**800**	**44**	**0.27**	**48**	**6.0**
C3	1600	33	0.27	49	4.5

T_{gr}=300°C

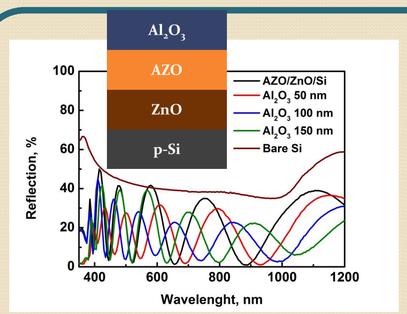


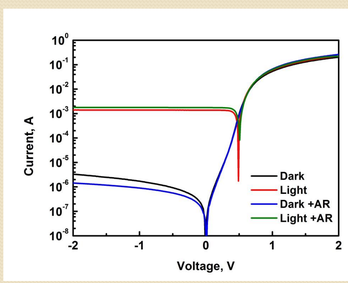


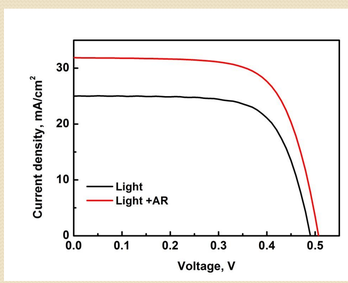


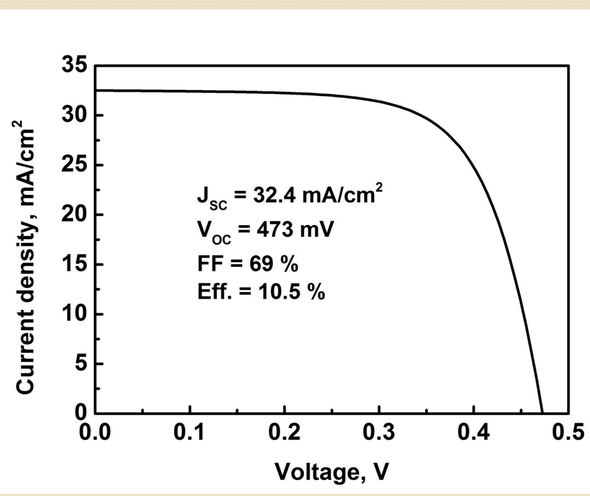


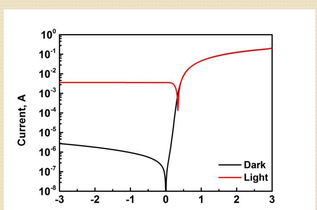
No.	Mg [%]	d [nm]	n [cm⁻³]	ρ [Ωcm]	J_{sc} [mA/cm²]	V_{oc} [V]	FF [%]	Eff. [%]
A1	1.6	150	$5.2x10^{19}$	$7.8x10^{-3}$	30.0	0.317	64	6.01
B1	**1.6**	**350**	**$2.9x10^{19}$**	**$1.3x10^{-2}$**	**33.7**	**0.319**	**66**	**7.5**
C1	1.6	550	$1.3x10^{19}$	$1.9x10^{-2}$	31.3	0.321	65	6.5

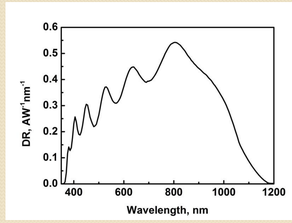


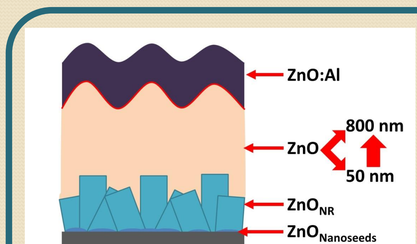


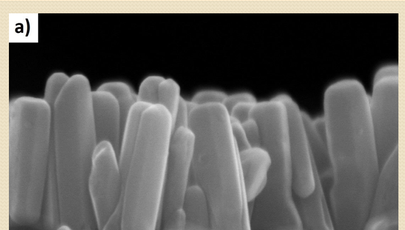


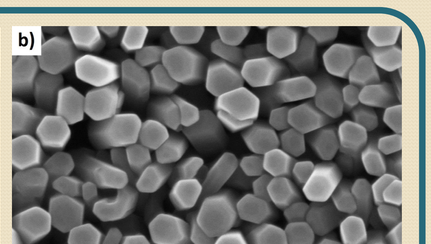


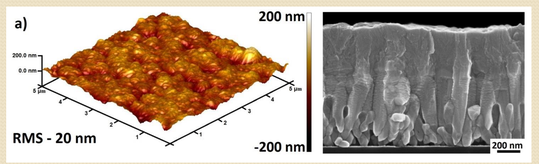


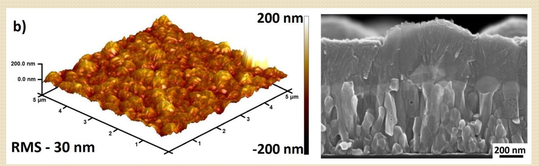


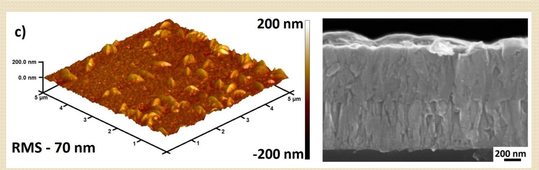


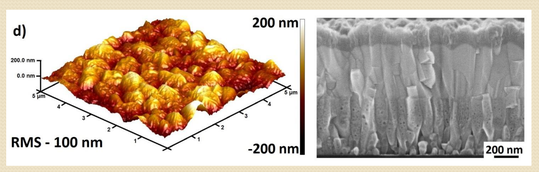


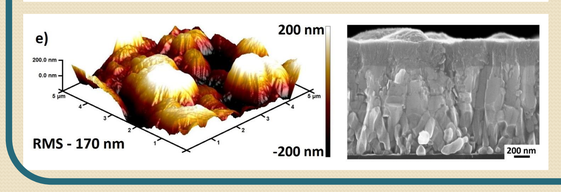


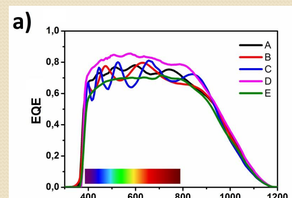


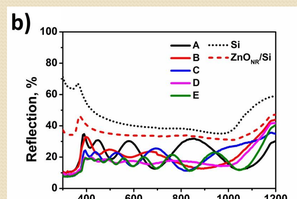


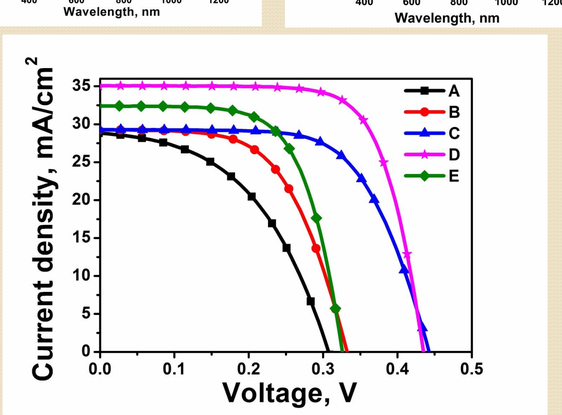




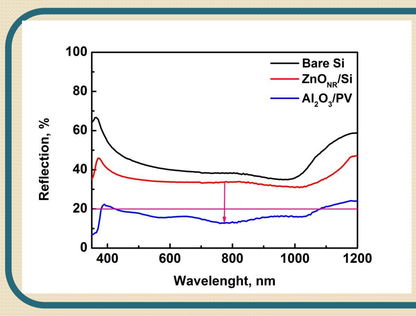


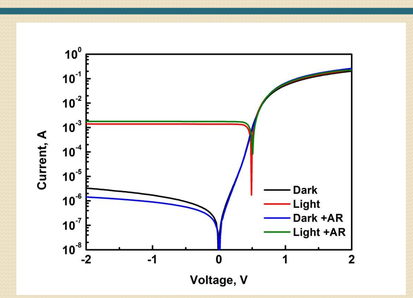


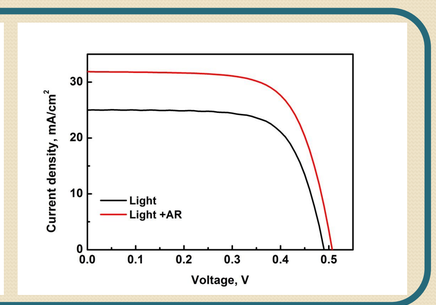


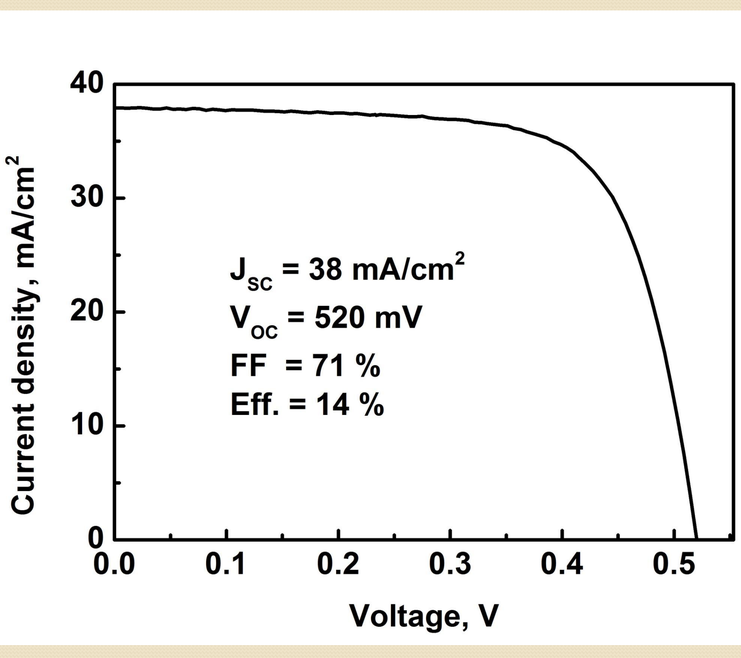


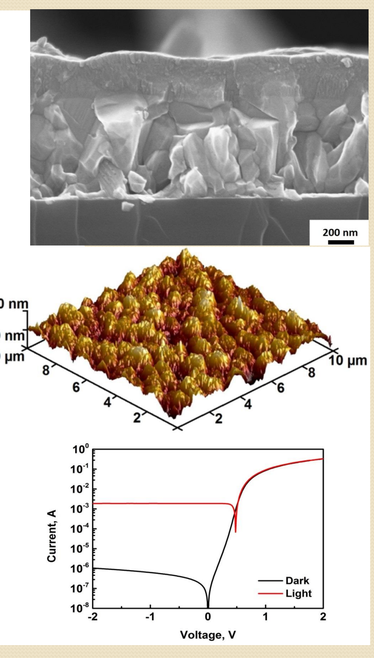
No.	AZO [nm]	ZnO [nm]	J_{sc} [mA/cm²]	V_{oc} [mV]	FF [%]	Eff. [%]
A		50	28.4	306	48	4.2
B		100	29.3	332	58	5.6
C	300	300	29.3	442	65	8.4
D		**500**	**35.1**	**435**	**71**	**10.9**
E		800	32.4	326	65	6.9











References:

[1] Pietruszka R., et al., **25** (2014), 190-196; doi: 10.1016/j.mssp.2013.11.026
[2] Pietruszka R., et al., **563** (2014), 28-31; doi: 10.1016/j.mssp.2013.11.026
[3] Pietruszka R., et al., **5** (2014), 173-179; doi: 10.3762/bjnano.5.17
[4] Semikina T., et al., **16** (2013) 111-116;
[5] Chusnutdinow S., et al., **126** (2014) 1072-1075;
[6] Witkowski B. S., et al., **11** (2014) 758-772; doi: 10.1504/IJNT.2014.063786

[7] Pietruszka R., et al., **Solar Energy Materials and Solar Cells**, " New efficient solar cell structure based on Zinc Oxide nanorods" **– in press**
[8] Jacak W., et al., **Physical Review B,** "On the size dependence and proximity limit for the plasmon effect of photo-voltaic efficiency enhancement" **– in press**
[9] Placzek-Popko E., et al., **Journal of Applied Physics,** " Si/ZnO nanorods/Ag/AZO structures as promising PV plasmonic cells" **– in press**

Conclusions:

In the present work we investigate electrical and optical properties of PV hetero-junctions aimed for the application in low costs PV devices. The process parameters are optimized to deposit ZnO films at fairly low temperature on silicon substrates. The over all PV efficiency for simple and cheap solar cells are 10.5 %.

We also investigate structures based on n-type ZnO nanorods grown by a low temperature hydrothermal method on low costs Si substrates. ZnO:Al and ZnO films were deposited on top of Si/nanorods structure by the atomic layer deposition (ALD) method. The efficiency of the so-obtained solar cells is equal 14.0 %

Acknowledgements :

This work was partially supported by the National Centre for Research and Development grant (PBS1/A5/27/2012), and (E. Zielony, P. Biegański and E. Popko) by the National Laboratory of Quantum Technologies (POIG. 02.02.00-00-003/08-00).