РОЗДІЛ 1
ПЕРЕДУМОВИ ТА ОСОБЛИВОСТІ ВИКОРИСТАННЯ АКТИВНОГО УЛЬТРАЗВУКА

1.1. Ефекти впливу ультразвука на мікроелектронні структури та матеріали

[1–25]:

In the literature, there are several models that describe the current–voltage ($I - V$) characteristics of the solar cells (SCs). These models contain some parameters, which reflect the processes within the structures and are related to the main characteristics of the photovoltaic conversion. So single diode model with three parameters has been used to represent the SC static characteristic because of simplicity:

$$I = I_0 \left[\exp\left(-\frac{qV}{nkT} \right) - 1 \right] - I_{ph} \,, \tag{1.1}$$

were

СПИСОК ВИКОРИСТАНИХ ДЖЕРЕЛ

1. Ishaque, Kashif. Simple, fast and accurate two–diode model for photovoltaic modules / Kashif Ishaque, Zainal Salam, Hamed Taheri // Sol. Energy Mater. Sol. Cells. — 2011. — Feb. — Vol. 95, no. 2. — Pp. 586–594.
2. Breitenstein, O. Understanding the current-voltage characteristics of industrial crystalline silicon solar cells by considering inhomogeneous current distributions / O. Breitenstein // Opto–Electronics Review. — 2013. — Sep. — Vol. 21, no. 3. — Pp. 259–282.
3. Parameters identification of photovoltaic models using an improved JAYA optimization algorithm / Kunjie Yu, J.J. Liang, B.Y. Qu et al. // Energy Conversion and Management. — 2017. — Oct. — Vol. 150. — Pp. 742–753.
4. Olikh, O.Ya. Acoustically driven degradation in single crystalline silicon solar cell / O.Ya. Olikh // Superlattices Microstruct. — 2018. — May. — Vol. 117. — Pp. 173–188.
5. Nguyen, Hieu T. Temperature dependence of the radiative recombination coefficient in crystalline silicon from spectral photoluminescence / Hieu T. Nguyen, Simeon C. Baker-Finch, Daniel Macdonald // Appl. Phys. Lett. — 2014. — Mar. — Vol. 104, no. 11. — P. 112105.
6. Assessment and parameterisation of Coulomb–enhanced Auger recombination coefficients in lowly injected crystalline silicon / Pietro P. Altermatt, Jan Schmidt, Gernot Heiser, Armin G. Aberle // J. Appl. Phys. — 1997. — Nov. — Vol. 82, no. 10. — Pp. 4938–4944.
7. Zoth, G. A fast, preperetion-free method to detect irpn in silicon / G. Zoth, W. Bergholz // J. Appl. Phys. — 1990. — Jun. — Vol. 67, no. 11. — Pp. 6764–6771.
8. Geerligs, L. J. Dynamics of light-induced FeB pair dissociation in crystalline silicon / L. J. Geerligs, Daniel Macdonald // Appl. Phys. Lett. — 2004. — Nov. — Vol. 85, no. 22. — Pp. 5227–5229.
9. Chollet, François. Deep Learning with Python / François Chollet. — Second edition. — Manning, 2017.

10. Degradation of Crystalline Silicon Due to Boron–Oxygen Defects / Tim Niewelt, Jonas Schöon, Wilhelm Warta et al. // IEEE Journal of Photovoltaics. — 2017. — Jan. — Vol. 7, no. 1. — Pp. 383 –398.
11. Rougieux, Fiacre E. Determining the charge states and capture mechanisms of defects in silicon through accurate recombination analyses: A review / Fiacre E. Rougieux, Chang Sun, Daniel Macdonald // Sol. Energy Mater. Sol. Cells. — 2018. — Dec. — Vol. 187. — Pp. 263 – 272.
12. Schmidt, Jan. Effect of Dissociation of Iron–Boron Pairs in Crystalline Silicon on Solar Cell Properties / Jan Schmidt // Progress in Photovoltaics: Research and Applications. — 2005. — Jun. — Vol. 13, no. 4. — Pp. 325–331.
13. Temperature dependence of photoconversion efficiency in silicon heterojunction solar cells: Theory vs experiment / A. V. Sachenko, Yu. V. Kryuchenko, V. P. Kostylyov et al. // J. Appl. Phys. — 2016. — Jun. — Vol. 119, no. 22. — P. 225702.
14. Couderc, Romain. Reassessment of the intrinsic carrier density temperature dependence in crystalline silicon / Romain Couderc, Mohamed Amara, Mustapha Lemiti // J. Appl. Phys. — 2014. — Mar. — Vol. 115, no. 9. — P. 093705.
15. Iron-boron pairing kinetics in illuminated p-type and in boron/phosphorus co-doped n-type silicon / Christian Möller, Til Bartel, Fabien Gibaja, Kevin Lauer // J. Appl. Phys. — 2014. — Jul. — Vol. 116, no. 2. — P. 024503.
16. Solar Cells. Materials, Manufacture and Operation / Ed. by Augustin McEvoy, Tom Markvart, Luis Castaner. — Second edition. — Oxford: Academic Press, 2013. — 641 pp.
17. Mohamed, Ali W. Novel mutation strategy for enhancing SHADE and LSHADE algorithms for global numerical optimization / Ali W. Mohamed, Anas A. Hadi, Kamal M. Jambi // Swarm Evol. Comput. — 2019. — Nov. — Vol. 50. — P. 100455.
18. Macdonald, D. Measuring dopant concentrations in compensated p–type crystalline silicon via iron–acceptor pairing / D. Macdonald, A. Cuevas, L. J. Geerligs // Appl. Phys. Lett. — 2008. — May. — Vol. 92, no. 20. — P. 202119.

19. New guidelines for a more accurate extraction of solar cells and modules key data from their current–voltage curves / Bertrand Paviet-Salomon, Jacques Levrat, Vahid Fakhfouri et al. // Prog. Photovoltaics Res. Appl. — 2017. — Jul. — Vol. 25, no. 7. — Pp. 623–635.
20. Formation rates of iron-acceptor pairs in crystalline silicon / Daniel Macdonald, Thomas Roth, Prakash N. K. Deenapanray et al. // J. Appl. Phys. — 2005. — Oct. — Vol. 98, no. 8. — P. 083509.
21. Оліх, О.Я. Дефекти у напівпровідникових та діелектричних кристалах / О.Я. Оліх. — Вінниця: ФОП Корзун Д.Ю., 2016. — 152 с.
22. Influence of γ–irradiation and ultrasound treatment on current mechanism in Au-SiO_2-Si structure / A.M. Gorb, O.A. Korotchenkov, O.Ya. Olikh et al. // Solid-State Electron. — 2020. — Mar. — Vol. 165. — P. 107712.
23. Olikh, O. Deep-learning approach to the iron concentration evaluation in silicon solar cell / O. Olikh, O. Lozitsky, O. Zavhorodnii // 9 European conference on renewable energy systems. Proceedings. Istanbul, Turkey. / Ed. by Erol Kurt. — Istanbul: 2021. — P. 22.
24. Acoustically Induced Acceleration of Iron Migration in Silicon Solar Cells / O. Olikh, V. Kostylyov, V. Vlasiuk, Korkishko R. // Ultrasonics 2021, 5th International Caparica Conference on Ultrasonic based Applications: from analysis to synthesis. Proceedings Book. Caparica, Portugal. — Caparica: 2021. — P. 109.
25. Estimation of Iron Concenration in Silicon Solar Cell by Kinetics of Light-Induced Change in Short-Circuit Current / O. Olikh, V. Kostylyov, V. Vlasiuk, Korkishko R. // II International Advanced Study Conference Condensed Matter and Low Temperature Physics CM&LTP 2021. Book of Abstracts. Kharkiv, Ukraine. — Kharkiv: 2021. — P. 191.