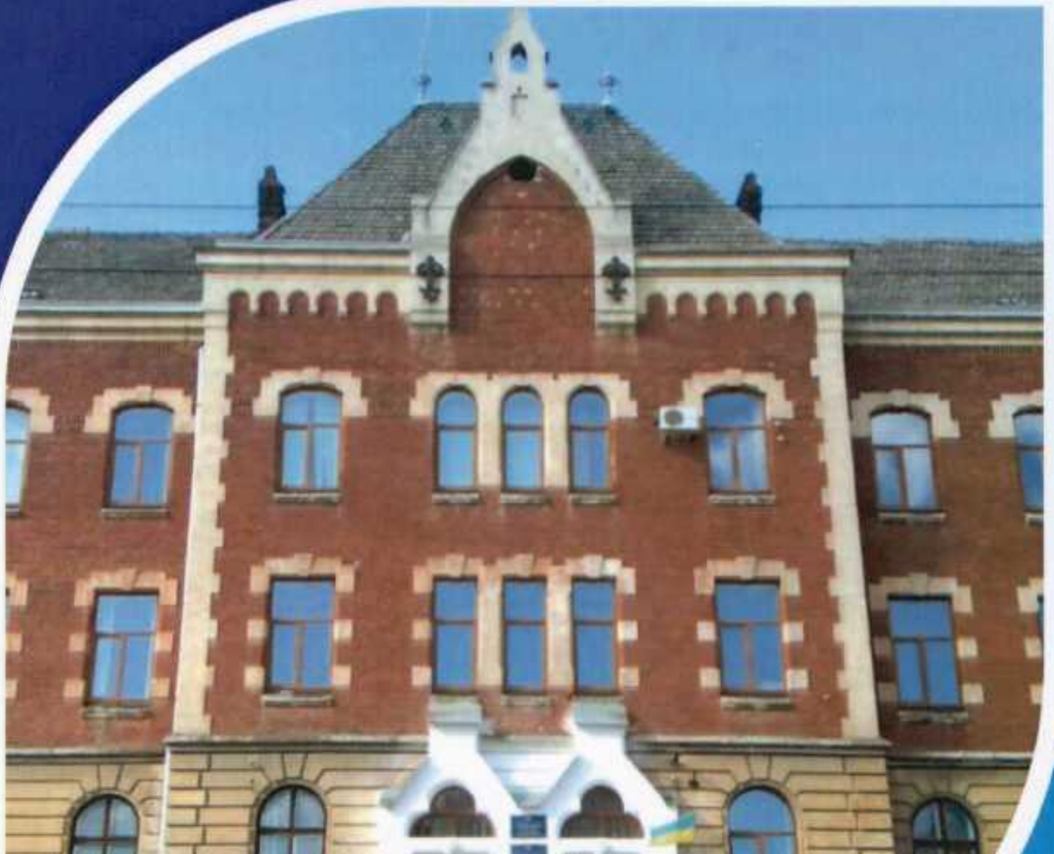
XI-th International Conference

Topical Problems of Semiconductor Physics

MATERIALS of Conference



Drohobych, UKRAINE

May 27-31, 2024

Ministry of Education and Science of Ukraine

Institute of Physics of NASU

V.E. Lashkaryov Institute of Semiconductor Physics NAS of Ukraine

Scientific Council “Semiconductor and Dielectric Physics”
at Physics and Astronomy Department of NASU

Drohobych Ivan Franko State Pedagogical University

XI-th International Conference

TOPICAL PROBLEMS OF SEMICONDUCTOR PHYSICS

Prykarpattya,
Drohobych, UKRAINE
MAY 27-31, 2024

Proceedings of the XI-th International Conference “Topical Problems of Semiconductors Physics” / Edited by Ihor Stolyarchuk. – Drohobych : Publishing Department of Ivan Franko DSPU, 2024. – 86 p.

Actual problems and important achievements of modern semiconductors physics are presented in the Proceedings of the XI-th International Conference “Topical Problems of Semiconductors Physics”. The abstracts are grouped into 7 sections, according to the Conference Thematic: “Section A. New frontiers in semiconductors and their based structures for electronics, optoelectronics, spintronic and sensing”, “Section B. Semiconductor low-dimensional structures: advances in synthesis, characterization, theoretical modeling and applications”, “Section C. The semiconductors for LEDs, solar and related energy technologies and sensor materials”, “Section D. Synthesis, processing and characterization of multifunctional oxide materials”, “Section E. Advanced strategies for smart functional and multifunctional bionanomaterials and biointerfaces”, “Section F. Laser material processing: from fundamental interactions to innovative applications”, “Section G. Modern computational methods and their applications in materials science: Synergy of theory and experiment”. The Proceedings were prepared for publication by the Conference Program Committee and presented in the author’s edition.

Recommended for publication by the Academic Council of Drohobych Ivan Franko State Pedagogical University.

Machine Learning-Based Characterization of Recombination Active Defects in Photovoltaic Cells

Zavhorodnii O.V., Olikh O.Ya.

Taras Shevchenko National University of Kyiv, Kyiv, Ukraine, nevermor464@gmail.com

The application of artificial intelligence, particularly machine learning (ML), in renewable energy research is gaining traction [1]. Recent studies increasingly employ photoluminescence spectroscopy and ML to investigate defect recombination in solar cells (SC). However, the majority of these studies are not specifically related to point defects. Our study aims to develop a cost-effective ML-based approach for characterizing point defect in silicon SC using I-V measurements.

To showcase our methodology, we focused on assessing the concentration of iron-related defects (Fe_i and Fe_iB_s). Using SCAPS-1D software, we modeled SC characteristics under standard AM1.5 and monochromatic (940 nm) illuminations. The modeled I-V curves provided insight into iron impurity states, allowing us to derive relative changes in short-circuit current (εIsc), open-circuit voltage (εVoc), efficiency (εη), and fill factor (εFF) post Fe_iB_s pairs decay. ML methods, including deep neural networks (DNN), random forest (RF), and gradient boosting (GB), were employed to estimate iron concentration. Prediction accuracy was compared across different lighting conditions and descriptor numbers, encompassing base depth, doping level, temperature, εIsc, εη, εVoc, and εFF. Results are presented in Table 1.

Table 1. Accuracy of iron concentration prediction for test dataset

Algorithm	Number of descriptors	MSE (10^{-3})		MRE (%)		R^2	
		illumination					
		AM 1.5	940 nm	AM 1.5	940 nm	AM 1.5	940 nm
DNN	4	49	10	115	14	0.924	0.972
	5	5	4	13	8	0.991	0.981
	6	2	3	8	9	0.993	0.899
	7	0.6	2	3	9	0.998	0.977
RF	4	41	2	83	8	0.939	0.982
	5	10	3	16	10	0.963	0.977
	6	5	3	10	11	0.971	0.968
	7	5	4	10	12	0.975	0.956
GB	4	41	2	66	7	0.949	0.978
	5	12	2	18	8	0.966	0.969
	6	5	2	9	9	0.970	0.973
	7	4	3	9	11	0.981	0.959

1. Dwivedi P., Weber J. W., Lee Chin R., Trupke T., Hameiri Z. Deep learning method for enhancing luminescence image resolution. *Solar Energy Materials and Solar Cells*, 2023, V. 257, P. 112357.