Національний фонд досліджень України
Конкурс проєктів із виконання наукових досліджень і розробок
"Підтримка досліджень провідних та молодих вчених"

Етапи та календарний план виконання проєкту учасника конкурсу

Project Title
Development of physical base of both acoustically controlled modification and machine learning-oriented characterization for silicon solar cells

Scientific head of the project
Olikh Oleg Yaroslavovych, doctor of science (physics and mathematics), associate professor

4. The project implementation stages and schedule of the tender participant
4.1. The project implementation stage (PIS) and performance indicators

PIS № 1: 15.09.2020 -30.09.2020
PIS Title: The project's material and computation base formation.
PIS Objectives: The preparation for calculations and measurements.

Task 1. The development of a calculation model of silicon n^+-p-p^+ structure for using in solar cell simulation program SCAPS 3.3.08; the model must take into account real values and temperature dependences of parameters for silicon and traps from modern literature; development of software for auto-creation model with various parameters.
Task 2. The selection of silicon solar cells (SSCs) with a boron doped base and a high iron impurity concentration.

The performance indicators:
the software for auto-creation model of n^+-p-p^+ structure for solar cell simulation program SCAPS 3.3.08; set of SSC with various doping degree.

PIS № 2: 01.10.2020-15.12.2020
PIS Title: The numerical simulation of current-voltage characteristics of n^+-p-p^+ structure.
PIS Objectives: To calculate an data array of IVC of n^+-p-p^+ structure with various parameters, to test a technique for measuring the kinetics of light-induced processes in SSC.

Task 1. The development of software for parsing of SCAPS result file; the calculation of IVC for silicon n^+-p-p^+ structures with different base thickness (150-240 μm), base doping level (10^{15}-10^{17} cm^{-3}), impurity concentration (10^{10}-10^{13} cm^{-3}) over the temperature range 290-340 K.
Task 2. The testing f procedure for measuring the kinetics of light-induced processes in SSC.
Task 3. The preparation of a presentation for an international conference.
Task 4. The equipment purchase.

The performance indicators:
the data array of calculated IVC for silicon n^+-p-p^+ structures with various geometric and electrophysical characteristics; the software for parsing of SCAPS result file; a prepared presentation; test results of measuring of kinetics of light-induced processes in SSC; prepared documentation for the equipment purchase.

PIS № 3 : 01.01.2021 -31.03.2021
PIS Title: The development of procedure for estimation of IVC kinetic parameters under ultrasound loading conditions.

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PIS Objectives: to implement procedure for estimation of kinetic parameter of defect rebuilding in barrier structures under ultrasound loading conditions; to fit IVC data array accordingly to the two-diode model.

Task 1. The development of procedure for estimation of kinetic parameter of defect rebuilding in barrier structures under ultrasound loading conditions. Testing measurements.

Task 2. The determination of influence of light-induced Fe-B pair dissociation on the IVC parameters (an ideality factor, a saturation current, a shunt resistance, an open-circuit voltage, a short-circuit current) of silicon solar cells; the quantification of kinetic of IVC parameters change induced by Fe-B pair association.

Task 3. The software implementation of the meta-heuristic optimization method Jaya; determination of ideality factor value for the calculated IVC array according to the two-diode model.

Task 4. The preparation of a presentation for an international conference.

Task 5. The equipment purchase.

The performance indicators:

the setup of for estimation of kinetic parameter of defect rebuilding in barrier structures under ultrasound loading conditions; the quantification of influence of light-induced Fe-B pair dissociation on the IVC parameters; the software for Jaya implementation; the data array of ideality factor value for silicon n^+-p-p^+ structures with various geometric and electrophysical characteristics; a prepared presentation; prepared documentation for the equipment purchase.

PIS № 4 : 01.04.2021 -30.06.2021

PIS Title: Making of an artificial neural network for estimating the concentration of iron in SSC.

PIS Objectives: to find out the physical regularities of acousto-defective interaction in SSC under longitudinal ultrasound loading; to make an artificial neural network for estimation of impurity iron atom concentration by IVC parameters.

Task 1. The determination of regularities of SSC parameters change, which forced by light-induced degradation, under longitudinal ultrasonic loading condition.

Task 2. The determination of kinetic characteristics of IVC parameters variation due to Fe-B pair association under longitudinal ultrasonic loading condition

Task 3. The tinning of hyperparameters of an artificial neural network capable of predicting the impurity iron atom concentration by ideality factor value; neural network training.

Task 4. The preparation of a presentation for an international conference.

The performance indicators:

the recognized physical regularities of interaction of defect complexes, which associated with transition metal atoms, and longitudinal elastic waves; the tuned an artificial neural network for estimating the concentration of iron in n^+-p-p^+ structures; a prepared presentation;

PIS № 5 : 01.07.2021 -30.09.2021

PIS Title: The transverse ultrasonic waves as a tool for SSC parameter driving.

PIS Objectives: to find out the physical regularities of interaction of defect complexes, which associated with transition metal atoms, and transverse ultrasonic waves in SSC.

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Task 1. The determination of regularities of SSC parameters change, which forced by light-induced degradation, under transverse ultrasonic loading condition.

Task 2. The determination of kinetic characteristics of IVC parameters variation due to Fe-B pair association under transverse ultrasonic loading condition

Task 3. The paper preparation.

The performance indicators:

the recognized physical regularities of interaction of defect complexes, which associated with transition metal atoms, and longitudinal elastic waves; a prepared paper.

PIS № 6 : 01.10.2021 - 15.12.2021

PIS Title: The specification of physical mechanisms of acousto-defective interaction and development of recommendations for practical use.

PIS Objectives: to summarize of the project obtained results in the recommendations.

Task 1. The determination of the physical mechanisms of the influence of acoustic waves on the rebuilding of defect complexes, which associated with transition metal atoms, in SSC.

Task 2. The development of recommendations about practical using of ultrasound loading during SSC manufacturing.

Task 3. The development of recommendations for the method of quantitative evaluation of electrically active defects in barrier structures by the ideality factor value

Task 4. The paper preparation.

The performance indicators:

the explored physical mechanisms of the interaction between defect complexes, which associated with transition metal atoms, in SSC and ultrasonic waves; the recommendation both for the practical use of ultrasound loading in SSC manufacturing and for the quantitative evaluation of electrically active defects in barrier structures by the ideality factor value; a prepared paper

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4.2. Project implementation schedule (by quarters)

Project implementation stage and tasks	Implementation period					
	Year 1		Year 2			
	3 quarter	4 quarter	1 quarter	2 quarter	3 quarter	4 quarter
1. The project's material and computation base formation	+					
Task 1. The development of a calculation model of silicon n^+-p-p^+ structure for using in solar cell simulation program SCAPS 3.3.08; the model must take into account real values and temperature dependences of parameters for silicon and traps from modern literature; development of software for auto-creation model with various parameters	+					
Task 2. The selection of silicon solar cells (SSCs) with a boron doped base and a high iron impurity concentration.	+					
Funding amount, thousand uah	72,3					
2. The numerical simulation of current-voltage characteristics of n^+-p-p^+ structure		+				
Task 1. The development of software for parsing of SCAPS result file; the calculation of IVC for silicon n^+-p-p^+ structures with different base thickness (150-240 μm), base doping level (10^{15}-10^{17} cm^{-3}), impurity concentration (10^{10}-10^{13} cm^{-3}) over the temperature range 290-340 K		+				
Task 2. The testing f procedure		+				

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for measuring the kinetics of light-induced processes in SSC					
Task 3. The preparation of a presentation for an international conference	+				
Task 4. The equipment purchase.					
Funding amount, thousand uah	2947,6				
3. The development of procedure for estimation of IVC kinetic parameters under ultrasound loading conditions		+			
Task 1. The development of procedure for estimation of kinetic parameter of defect rebuilding in barrier structures under ultrasound loading conditions. Testing measurements		+			
Task 2. The determination of influence of light-induced Fe-B pair dissociation on the IVC parameters (an ideality factor, a saturation current, a shunt resistance, an open-circuit voltage, a short-circuit current) of silicon solar cells; the quantification of kinetic of IVC parameters change induced by Fe-B pair association		+			
Task 3. The software implementation of the meta-heuristic optimization method Jaya; determination of ideality factor value for the calculated IVC array according to the two-diode model		+			
Task 4. The preparation of a presentation for an international conference		+			

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Task 5. The equipment purchase						
Funding amount, thousand uah			1772,8			
4. Making of an artificial neural network for estimating the concentration of iron in SSC				+		
Task 1. The determination of regularities of SSC parameters change, which forced by light-induced degradation, under longitudinal ultrasonic loading condition				+		
Task 2. The determination of kinetic characteristics of IVC parameters variation due to Fe-B pair association under longitudinal ultrasonic loading condition				+		
Task 3. The tinning of hyperparameters of an artificial neural network capable of predicting the impurity iron atom concentration by ideality factor value; neural network training				+		
Task 4. The preparation of a presentation for an international conference				+		
Funding amount, thousand uah				617,5		
5. The transverse ultrasonic waves as a tool for SSC parameter driving					+	
Task 1. The determination of regularities of SSC parameters change, which forced by light-induced degradation, under transverse ultrasonic loading condition					+	

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Task 2. The determination of kinetic characteristics of IVC parameters variation due to Fe-B pair association under transverse ultrasonic loading condition					+	
Task 3. The paper preparation					+	
Funding amount, thousand uah					606,4	
6. The specification of physical mechanisms of acousto-defective interaction and development of recommendations for practical use						+
Task 1. The determination of the physical mechanisms of the influence of acoustic waves on the rebuilding of defect complexes, which associated with transition metal atoms, in SSC						+
Task 2. The development of recommendations about practical using of ultrasound loading during SSC manufacturing						+
Task 3. The development of recommendations for the method of quantitative evaluation of electrically active defects in barrier structures by the ideality factor value						+
Task 4. The paper preparation						+
Funding amount, thousand uah						492,2