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REVIEWER'S REPORT

Manuscript No.: IJAR-56662

Title: AC BACK SURFACE RECOMBINATION VELOCITY AND OPTIMUM BASE THICKNESS IN AN IRRADIATED N+–P–P+ SILICON SOLAR CELL UNDER TEMPERATURE AND FREQUENCY MODULATION

Recommendation:
Accept

Rating	Excel.	Good	Fair
Originality	Yes		
Techn. Quality	Yes		
Clarity		Yes	
Significance		Yes	

Reviewer Name: Dr. Ashish Yadav

Detailed Reviewer's Report

Reviewer's Comment for Publication.
Acceptance Comment are mentioned below suitable for the paper titled "AC BACK SURFACE RECOMBINATION VELOCITY AND OPTIMUM BASE THICKNESS IN AN IRRADIATED N+–P–P+ SILICON SOLAR CELL UNDER TEMPERATURE AND FREQUENCY MODULATION."

Reviewer Comments: Accept

Reviewer Comments –

1. Introduction
The manuscript addresses an important topic in the field of Photovoltaics and Semiconductor Physics by investigating the optimization of base thickness in an irradiated n^+–p–p^+ silicon solar cell under AC polychromatic illumination and temperature variation. The introduction clearly highlights the significance of minimizing recombination losses and improving carrier transport properties to enhance solar cell efficiency. The authors successfully explain how irradiation, temperature, and frequency modulation influence minority carrier behavior in the base region of the solar cell. The motivation for applying the AC back surface recombination velocity approach to determine optimum base thickness is well presented.

2. Literature Review
The literature review provides a relevant overview of previous studies related to minority carrier transport, recombination mechanisms, and analytical modeling of silicon solar cells. The authors appropriately reference earlier theoretical works that investigate the effects of irradiation and recombination velocity on photovoltaic performance. The discussion establishes a good foundation for understanding the need for improved optimization techniques in solar cell design. Nevertheless, the section could be strengthened by incorporating more recent research contributions published in the past

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decade and by explicitly highlighting how the current work differs from existing models. A clearer comparison with prior analytical and numerical approaches would further demonstrate the contribution of this study.

3. Solution Approach / Methodology

The methodological framework of the study is clearly developed and forms one of the main strengths of the manuscript. The authors derive analytical expressions by solving the minority carrier continuity equation in the base region under modulated illumination conditions while incorporating the effects of irradiation energy flux, damage coefficient, temperature variation, and frequency modulation. The formulation of two components of the back surface recombination velocity (Sb_1 and Sb_2) and the determination of optimum base thickness through their intersection represent a logical and effective analytical approach. The modeling assumptions appear physically reasonable and consistent with semiconductor transport theory. However, the clarity of this section could be improved by providing a brief schematic representation of the n^+–p–p^+ solar cell structure and clearly defining all parameters used in the mathematical expressions.

4. Results and Discussion

The results and discussion section effectively illustrates how irradiation level, damage coefficient, temperature, and modulation frequency influence the optimum base thickness of the silicon solar cell. The graphical representation of the back surface recombination velocity components Sb_1 and Sb_2 as functions of base thickness provides a clear visualization of the optimization process. The results demonstrate that increasing irradiation and damage coefficient lead to higher recombination rates, thereby reducing the optimum base thickness, while temperature and frequency significantly affect minority carrier diffusion properties. The authors provide meaningful physical interpretations of these trends, linking them to changes in diffusion coefficient and carrier lifetime. Nonetheless, the discussion could be further strengthened by including quantitative comparisons with previous studies and by elaborating on the practical implications of these findings for photovoltaic device design.

5. Conclusion

The conclusion summarizes the key findings of the study in a concise and coherent manner. The authors successfully demonstrate that the AC back surface recombination velocity approach can be used as a reliable method for determining the optimum base thickness of an irradiated silicon solar cell under varying environmental conditions. The results confirm that irradiation damage, temperature variation, and frequency modulation significantly influence minority carrier transport and recombination behavior, ultimately affecting solar cell performance. The conclusions are consistent with the presented analytical and numerical results and highlight the importance of optimizing structural parameters in photovoltaic device design.

The study provides several potential directions for future research aimed at further improving photovoltaic device modeling and optimization. Future work may focus on experimental validation of the proposed theoretical model to confirm the predicted trends in optimum base thickness under irradiation conditions. Additionally, the analytical framework could be extended to investigate other advanced photovoltaic materials such as Perovskite Solar Cells or compound semiconductor devices like Gallium Arsenide solar cells. Further research may also explore the influence of additional recombination mechanisms, interface defects, and multilayer structures, as well as the integration of numerical simulations and experimental characterization techniques to enhance the practical applicability of the model.