Email

Manuscript #	JR17-1447
Title	Simplified parameter extraction method for single and back-to-back Schottky diodes fabricated on Silicon-on-Insulator substrates
Corresponding Author	Vissarion Mikhelashvili (Technion - Israel Institute of Technology)
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Created By:	Ania Bukowski
From:	jap-edoffice@aip.org
To:	beso@ee.technion.ac.il
Subject:	JAP: MS #JR17-1447 Decision Letter
Email	Dear Dr. Mikhelashvili: Your manuscript, referenced below, has been reviewed for publication in the Journal of Applied Physics. It has been found to be of potential interest. "Simplified parameter extraction method for single and back-to-back Schottky diodes fabricated on Silicon-on-Insulator substrates" JR17-1447 However, based on reviewer comments, the recommendation is major revisions. The reviewer's comments are included below and/or attached. Please respond to the reviewer's critical comments. Please include a response letter that addresses each point and indicates how the manuscript has been revised as a separate document titled, Response Letter and submit a copy of the manuscript with the exact locations of the revisions titled, Marked Manuscript. The revised manuscript should be returned to the Editor promptly. Your revised manuscript is due 29-Jun-2017. A manuscript returned after 29-Jun-2017 will generally be regarded as new submission and will be assigned a new receipt date. Please go to the URL below to submit the revised version. To meet AIP Production requirements, please provide a separate figure file for each cited figure number (all parts in one file), in addition to your article-text file. Link Not Available (If clicking on the above URL address directly from your mail program is unsuccessful, please copy and paste the complete address into your browser.) Thank you for the opportunity to examine this work. If you have any questions, feel free to contact us at jap-edoffice@aip.org. Sincerely yours, Kin Man Yu, PhD Associate Editor, Journal of Applied Physics, and Professor of Physics and Materials Science

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PLEASE NOTE*
The appearance of your by-line and your author order of your data and your text is exactly the way it will be printed. Review it carefully now to ensure you are completely satisfied. No modifications will be accepted in the event your article is to be accepted for publication. Please make any needed changes promptly.
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Editor's Comments:

Reviewer Comments:
Reviewer #1 Evaluations:
Does the manuscript present original and timely results that significantly advance the knowledge in applied physics: No
Does the manuscript report on convincing and rigorous data methods and analysis: Yes
Is the manuscript clearly written in correct English well organized and free from ambiguities: No
Is the title descriptive of the contents concise interesting and free of acronyms: Yes
Does the abstract adequately and clearly describe the contents (problem approach findings) of the paper: Yes
Are the figures in the manuscript necessary adequate well presented and clearly labeled: No
Is the reference list appropriate: Yes

Reviewer #1 (REMARKS to AUTHOR(s)):

The authors describe a technique to extract room temperature parameters of Schottky diodes when barrier height is voltage dependent. This problem (characterization of Schottky barriers) has been exhaustively studied for the last six decades and will continue due to the importance of this issue to devices developing.
The manuscript describes a (new?) method for current-voltage characteristics analysis based on the differential slope of the experimental I-V curves. Some references cited in the manuscript (Refs. 17-23) already give a route for a similar analysis: using the early text book models (Physics of Semiconductors

Devices by S. M. Sze or the brilliant E. H. Rhoderick's Metal Semiconductor Contacts) and the differential slope of the experimental I-V curves one obtain the results presented here. In this sense, it appears to me that the paper does not present original results but instead only a different way (some parts already published, as cited in the manuscript) to extract out Schottky parameters.
Specific comments:
1. The authors claim that "The method was verified for MS, MSM and MISM structures with symmetric or asymmetric electrodes by measurement of the current voltage characteristics (I-V) at room temperature under different illumination regimes" but being a very studied subject why authors did not present a comparison with published or other "conventional" models?
2. From eq. (1) to eq. (2) there is a gap: eq. (1) describes only thermionic mechanism while eq. (2) present a combination of the thermionic and diffusion theory! Js1 or Js2 have not to account diffusion theory to be correct or to be used in eq. (1).
3. Authors wrote: "The Schottky barrier height is reduced in the dark due to both a variation of image force potential and a dipole layer, which results from an interfacial layer with surface trap states and or fixed charges at the MS boundary [1, 15, 16]. The barrier height reduces further under illumination [10]". The barrier reduces in dark conditions and reduces further under illumination. When does it increase?
4. Authors wrote: "...transmission coefficient of the barrier to be smaller than unity [15, 16])....". Is that reasonable for the diodes studied here?
5. Experimental part:
5a. A commercial Schottky diode was used: which one?
5b. A figure of the devices built for this work should be presented.
6. When describing the results, authors wrote " The perfect coincidence testifies to the strength of the proposed method, which is simpler than the complicated current versus temperature technique of extraction, zero bias barrier height of single Schottky diodes [1]. " Why complicated? It has been used since 60´s without problems!
Also, the coincidence claimed by the authors is related to two equations described in the manuscript. Why there is not a comparison with published results?

7. Authors wrote: "The reason is that interfacial states would lead to an exponential dependence of the reverse saturation current on applied voltage and therefore a linear increase of α with applied voltage, as predicted by equations (2) or (8) taking into consideration (3) and (4)." What distribution shape was authors using to describe the density of states? Constant density? Gaussian distribution? Please check Barret C. Thesis University of Paris-Sud, Orsay (1981); Barret C and Vapaille A, Solid State Electron. 18, 25 (1975).

Minor points:
1. English should be improved: some phrases are confuse.
2. In page 5, after eq. (7) authors wrote: "...respectively, for n and p type semiconductors.", but only in eq. (7) n and p type semiconductors are distinguished.

3. In page 5, authors give a description of a lot of constants. These constants are well known from literature and a reference is good enough to address the reader to their meanings. After all, authors do not work out these constants all through the paper.
4. The authors wrote "The technique we propose does not require to resort to complicated graphical differentiation technique [24, 25] or to technique, which

are only valid under limited conditions [26]." They should re-phrase this.

Reviewer #2 Evaluations:
Does the manuscript present original and timely results that significantly advance the knowledge in applied physics: Yes
Does the manuscript report on convincing and rigorous data methods and analysis: Yes
Is the manuscript clearly written in correct English well organized and free from ambiguities: Yes
Is the title descriptive of the contents concise interesting and free of acronyms: Yes
Does the abstract adequately and clearly describe the contents (problem approach findings) of the paper: Yes
Are the figures in the manuscript necessary adequate well presented and clearly labeled: Yes
Is the reference list appropriate: Yes

Reviewer #2 (REMARKS to AUTHOR(s)):

The paper is devoted to the new method of the current mechanism determination and barrier height extraction. Authors are bringing into community the method, which is based on using of the differential slope of the reverse current-voltage
characteristic. Conclusions and abstract reflect main results of the article. References are appropriate. The work could be interesting for JAP. I have minor comments:

1. The term "kT/q" in equations, located in the last column of Table 1 (second, third and fourth rows) must be replaced by "kT" (or "qΔφ, eV" must be replaced by "Δφ, V" in the first row).

2. At many real MS interfaces, the ideality factor is included in the description of the junction current. The greater-than-unity ideality factor (and bias dependence of a SBH) can be caused by not only image force and interface states but also thermionic field emission, generation-recombination, SBH inhomogeneity. The expected behavior of the differential slope of the I-V characteristics in the last cases would be interesting .

3. "V" must be replaced by "Vr" in the Eq.(4), Fig.3(c).

4. The reason for selection of illumination wave length (365 nm) should be discussed.

5. Possibly, the semi-log scale is more relevant for the Fig.3(b).

6. If the dependence on Fig.3(c) is described by the Eq.(6) then it is possible to determinate the Vbi and Nd values. So, the comparison of the extracted donor concentration and built-in voltage with known sample parameters can be important part of the experimental verification of the introduced method.

7. It is claimed (page 10, first and second paragraphs from the bottom) that "ideality factor ...in the present case is 1.12... The small deviation of the ideality factor from a value of unity indicates that the current flow by thermionic emission is

disturbed by the effect of the voltage dependent image force potential".
However n=1.12 is too much for image force influence. In this case
n=1+0.25*(q^3 Nd / 8 Pi^2 (eo es Vbi)^3)^0.25
One can calculate, that for n=1.12 and silicon
Nd=1.1e27 (Vbi)^3 1/m^3.
Therefore semiconductor is degenerate, or diffusion potential is too small, or ideality factor value is not determined by image force. The last version is most probable. It is important to report some details about this situation in the text.

8. On my humble opinion, while referring on equation from table it is better to use (number) than raw and column.

9. Figure 4 (e) shows the barrier height alteration under illumination. On the one hand, quasi-Fermi level position can be calculated by eqs.(4) and (7). On the another hand, quasi-Fermi level position depend on non-equilibrium carrier concentration, which is determined by illumination power. The comparison of results, which obtained by this different way, would be interesting.

10. Page 12, 3-rd paragraph from the top: "In the dark and at small illumination powers, Δφo values were extracted by the equation of raw II, column IV in table 1 while at large illuminations, we used the equation of row I, column IV."
Which is rigorous criterion for every equation using (or separation of small and large illuminations)?

11. Page 13, 1-st paragraph from the top: "(see inset in Fig. 2 (b))" must be replaced by "(see inset in Fig. 6 (b)) "

12. Figure 7 presents zero bias barrier height. At such condition Vr equals to zero. Therefore expressions in row I and row III are equivalent. Why are results obtained from reverse and forward branches different?

13. The word "raw" (pages 12, 15) must be replaced by "row".

Reviewer #3 Evaluations:
Does the manuscript present original and timely results that significantly advance the knowledge in applied physics: Yes
Does the manuscript report on convincing and rigorous data methods and analysis: Yes
Is the manuscript clearly written in correct English well organized and free from ambiguities: Yes
Is the title descriptive of the contents concise interesting and free of acronyms: Yes
Does the abstract adequately and clearly describe the contents (problem approach findings) of the paper: Yes
Are the figures in the manuscript necessary adequate well presented and clearly labeled: No
Is the reference list appropriate: Yes

Reviewer #3 (REMARKS to AUTHOR(s)):

The presented work is good and interesting. The method presented is nicely explained with technical details and comparisons. The figures size is too big. Suggest changing the format.

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