



**Comment on “Simulation of Schottky and Ohmic contacts on CdTe” [J. Appl. Phys. 109, 014509 (2011)]**

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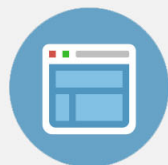
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## Comment on “Simulation of Schottky and Ohmic contacts on CdTe” [J. Appl. Phys. **109**, 014509 (2011)]

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In the present comment, it is argued why the model assumed in [J. Appl. Phys. **109**, 014509 (2011)] is inappropriate for the modeling of realistic detector grade semi-insulating CdTe devices. Amendments to the model to account for more realistic physics in devices based on semi-insulating materials are briefly pointed out. © 2012 American Institute of Physics. [doi:10.1063/1.3676282]

The work focused on simulations of contacts with a varying Schottky barrier height on “high resistivity, “semi-insulating,” semiconductors in general, and detector-grade CdTe” based on a finite element method was presented by Ruzin.<sup>1</sup> In the present comment, it is argued why the model assumed in Ref. 1 is inappropriate for the realistic detector-grade semi-insulating (SI) materials, and why the obtained results are unacceptable for the chosen class of material(s). The reported results are not discussed in detail. Amendments to the model to account for more realistic physics in devices based on SI materials are briefly pointed out.

The list of major drawbacks in Ref. 1 and their discussion follows: (i) in the abstract, the “detector grade CdTe material” is mentioned, however, according to the Simulation Section, the model used for SI CdTe contains only one single donor level (fully ionized or activation energy is missing in the text) with the unrealistic concentration of  $N_D = 10^6 \text{ cm}^{-3}$ , on the order of intrinsic concentration of CdTe at room temperature  $n_i \approx 10^6 \text{ cm}^{-3}$ .<sup>2,3</sup> Therefore, the model represents an idealized “quasi-intrinsic” case out of technology limits and misses the point because of the missing deep level(s). Typical detector-grade SI CdTe materials contain various deep and shallow levels with concentrations of at least  $10^{15} \text{ cm}^{-3}$ .<sup>3</sup> The most simplified acceptable realistic model of an SI material with a bandgap of CdTe should contain at least one shallow level and one deep compensation level (see, e.g., Ref. 4), with relevant concentrations, to account for effects caused by trapped charge populations.<sup>5</sup> The presence of traps implies a completely different physics compared to the trap-free case, e.g., the trap-captured minority carriers enhance the presence of majority carriers, leading to a contraction of the screening length.<sup>5,6</sup>

(ii) In the Introduction, the statement “The depletion approximation, assuming a constant space charge region, is not valid in the case of regular semi-insulating semiconductors (where low resistivity is not achieved by the introduction of deep level traps)” is contradictory, because of the fact that regular SI material is a synonym for high-resistivity material

in vast amount of real cases, not for a low-resistivity one. The corresponding high resistivity may be achieved by introduction of traps, participating in the overcompensation, to the low-resistivity material.

(iii) The solutions to the oversimplified model (as discussed in (i)), presented in the Results section, reveal no neutral region in a device as long as 4 mm, in direct contradiction to the familiar contraction of the screening length<sup>6</sup> in highly resistive SI materials. Related conclusive statements, such as “...depletion approximation approach cannot be used for high resistivity semiconductors” or the statement from (ii), may possibly mislead non-expert readers. Criticism of the work preceding Ref. 1, namely Refs. 7–9, where the depletion approximation is used on physical grounds, is therefore not justified.

To summarize, simulations involving suitable models and proper interpretation of obtained results are envisaged to understand complex phenomena in devices based on SI materials and SI CdTe, in particular.

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