

Minutes
of the 2nd RD50 Simulation Working Group meeting

CERN, March 27, 2013

Participants at CERN

1. Dabal Ranjeef, Delhi University, India
2. Eremin Vladimir, PTI, St. Petersburg, Russia
3. Gallrapp Christian, CERN, Switzerland
4. Härkönen Jaakko, HIP, Helsinki, Finland
5. Klanner Robert, Hamburg University, Germany
6. Lounis Abdenour, L.A.L. Orsay, France
7. Luukka Panja, HIP, Helsinki, Finland
8. Mandic Igor, JSI, Ljubljana, Slovenia
9. Moll Michael, CERN, Switzerland
10. Muenstermann Daniel, CERN, Switzerland
11. Neugebauer Hannes, CERN/Hamburg University, Switzerland/Germany
12. Peltola Timo, HIP, Helsinki, Finland
13. Vagelis Grougkousis, L.A.L. Orsay, France
14. van Beuzekom Martin, Niknef, Amsterdam, Netherlands
15. Verbitskaya Elena, PTI, St. Petersburg, Russia

Video conference was available.

Chare: Vladimir Eremin

1. The initially claimed goal which is the development of the approach for simulation of irradiated silicon detectors performance using professional software is under intensive advancement in several groups. **The first illustration of the SILVACO code applicability for simulation of the electric field in irradiated Si p-on-n detectors (1st SWG meeting, Bari, 2012) is now confirmed in several groups.** It was reported that the double peak $E(x)$ profile which is a specific feature for heavily irradiated Si detectors can be reproduced in the frames of two midgap energy level model proposed by PTI.
2. **The cross-test of software** available in different groups for simulation **shows that implementation of the bulk generated current as an independent and separately parameterized process** arisen from the charge carrier accumulation at the midgap energy levels (MGLs) **could not be realized with SILVACO code. Meanwhile, SYNOPSIS code can utilize it via the parameter “lifetime”.** However it is not clear yet how the mentioned parameter interferes with the concentration and the properties of the deep levels in Si and what is the levels contribution into the effective space charge concentration in the depleted region.
3. **Therefore it was concluded that in the future only microscopic parameters of the midgap energy levels will be used as an input parameters for simulation. This will allow using any existing software and continuing their cross-test.**
4. In presentation of PTI in Bari (20 RD50 workshop) **it was shown that two effective midgap levels MGL1 with $E_{DD}=E_v+0.48$ eV and MGL2 with $E_{DA} = E_v+0.595$ eV can be used for simulation of the leakage current as well as for $E(x)$ simulation. This approach is now under intensive development in several groups and the SWG considers it as a main subject for future.**
5. The bulk generated **current can be modeled using two parameters for each MGL** which are the **activation energy E_{MGL}** and the **product of the MGL concentration and their cross-section SIG ($M \times SIG$).** Therefore adjustment of **the SIG and the MGL introduction rate** (which is proportional to the concentration) **could be used for fitting of the $E(x)$ distribution and its transformation with fluence together with the dependence of the I_{bulk} vs. fluence.**

6. The participants accepted the task to collect the database for Si and the MGLs properties as a common platform for the modeling. ~~The details are presented in the attachment.~~

7. The dependence of E_g on temperature was actively discussed in terms of its influence on the MGL activation energy. It was accepted as a temporary solution that the $E_g(T)$ will be used where it is directly related with the band-to-band process like the intrinsic concentration dependence on temperature. At the same time this dependence will be disregarded for the definition of the MGL activation energy.

8. The following dependences will be “switched-off” in the simulation software:

- mobility vs. doping, fluence,
- saturated drift velocity vs. doping, fluence,
- MDL trapping cross-section vs. electric field.

9. The calculations of the electric field profile should be verified by the experimental data. In other words, the modeling must be calibrated by the experimental data on the electric field distribution. The edge TCT provides the most direct information on $E(x)$ distributions in the form of product $E(x) \times \mu(x)$. It was recommended for calibration or comparison to finalize simulations by calculation of the product $E(x) \times \mu(x)$.

10. Several problems were pointed in the discussion:

- Does the occupancy of MGL influences on their MGLs current generation efficiency?
- Do we need to calculate and parameterize the weighting electric field for the main configurations of the LHC detectors for simulation of the charge collection?

11. The long term strategy of the SWG was discussed. The strategy includes several steps which are subdivided now into two research lines:

- Line 1: adaptation of the professional software and the development of the common unified database for simulation with microscopic parameters of radiation induced defects (effective MGL);

- Line 2: extension of the model with one DD and one DA levels towards the simulation of the full set of the detector characteristics.

12. As a short term plan, it was proposed to be focused on two aspects:

- cross-tests of simulation soft wares,
- updating database,
- simulation of the CCE in irradiated detectors with the uniform weighting field (PAD geometry).

13. After each meetings PTI will prepare / update the set of essential data for the next step of simulation project and will distribute it inside the SWG.

The new points:

1. SWG is looking for any data which can improve the “Two MGL model”.
2. The new step in activity of SWG – simulation of the charge collection with the parameters from the SWG data base.
3. SWG data base will be updated for:
 - Current generation
 - Trapping during the charge collection
 - Parameterization of the transport properties
 - Parameterization of the avalanche multiplication process