HAPSPIDE

WP3 Simulation

18/11/2021

WP3 TASKs (description)

3.1 Modeling development/validation.

3.2 Geant4 simulations.

3.3 TCAD simulations: DC, (AC), transient analysis (CCE).

3.3 Optimization of a-Si:H devices: layout/geometries, operating conditions.

3.4 Radiation tolerance analysis.

WP3 Milestones

3.1 TCAD modeling of a-Si:H – M6.

3.2 Combined Geant4 + TCAD simulation environment set-up – M12.

3.3 Comparison between simulations and measurements – M18.

WP3 Deliverables / Timescale

3.1 a-Si:H TCAD material model with embedded physical models (e.g. carrier mobility) - M6.

3.2 Report on layout/geometry of dosimetric flux sensor - M12.

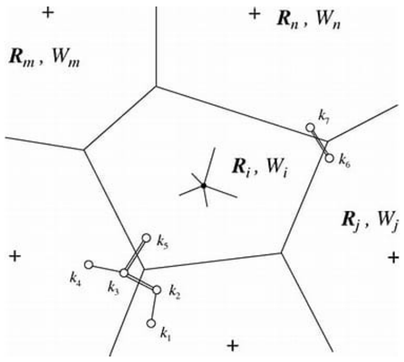
3.3 Report on layout/geometry of single particle sensor - M18.

3.4 Radiation damage model – M36

- WP3 Simulations – A twofold framework

  - **Dosimetric** measurements and **single particle** detection.
  - **Monte-Carlo** approach (**GEANT4**) , aiming at accurate description of the material/particle interaction accounting for secondary emission effects, linear energy transfer value variations, effect of packaging materials on tissue equivalency for charge particles and photons, simulation of the expected micro-dosimetric spectra for different sensitive volume geometries and charge particle beam energy (-> input for TCAD simulations…).
  - **Technology CAD (TCAD)** approach (**Sentaurus Synopsys TCAD**), aiming at accurate description of the charge transport within a-Si:H material and device electrical response (DC, transient simulations).
  - The **effect of the read-out mode** (e.g. single-event vs. continuous current measurement) can be self-consistently accounted for within TCAD simulation, exploiting the mixed device-circuit simulation embedded option.

- Innovation: a-Si:H not included in TCAD material library
  - Semiconductor (~ uniform domain macro properties) – band gap engineering (defects parametrization).
  - Atomistic scale ? (grain boundary effect, Voronoi domains).



- Charge Transport: mobility models
  - Poor modeling with existing models (e.g. Poole-Frenkel).
  - The (drift) mobility can't be straightforwardly inferred from the current density approximation
  - $J = AT^2\left[\exp\left(bT\sqrt{\frac{V}{d}}\right) - 1\right] \Leftrightarrow J = q\mu nE.$
  - Dependence of μ upon doping, electric field, …

- Study of LIFETIMES vs. MOBILITY models
  - Interplay in current densities calculations.

- Introduction of innovative materials (from TCAD perspective)
  - Transparent Contact Oxides (TCO) -> transport modeling within oxides.
  - Electrons/Holes selective Contacts -> selective mobility for e, h.

- Simulations vs. measurements @mobility/lifetimes models
  - Current activities/starting point.