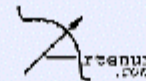


SPIS Numerical core

(or SPIS/NUM, or "the solvers")

Material interaction modelling

J.-F. Roussel, *ONERA / DESP*



Outline

- Photo-emission
- Secondary emission
- Induced conductivity
- General challenges

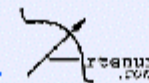
Photo-emission

➤ Yield:

- One of NASCAP properties (at 1 AU, scales with sun flux)
- Taken angle-independent (consistent with literature)

➤ Spectrum of photo-electrons:

- Current version
 - Maxwellian
 - Temperature can be controled through a global parameter:
photoElectronTemperature (typically 2-3 eV)
- Possible extensions:
 - 2 Maxwellians
 - Arbitrary spectrum (40 eV population...)



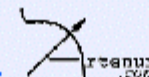
Secondary emission / true secondaries

➤ Yield:

- Follows NASCAP model
 - Based on yield maximum at normal incidence: Y_m , E_m
 - Other energies and angles derived from range function
- Flexibility/modularity:
 - Following NASCAP approach, range function can easily be changed (use a different RangeFunction object)
 - Changing approach, a different yield function can easily be changed
- Type of incident particle model:
 - If PIC: microscopic, this yield applied to each particle
 - If fluid (Boltzmann): isotropic yield is used
 - Transparent: Interactor object can handle any type of impinging distribution

➤ Spectrum of (true) secondary electrons:

- Maxwellian
- Temperature can be controled through a global parameter:
secondaryTemperature (typically 2-3 eV)



Secondary emission / backscattered electrons

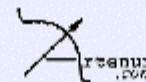
➤ Yield:

- Follows NASCAP model (looks rather crude)
- Small modification w.r.t. NASCAP (to be improved):
 - Yield = 0.5 for dielectrics at low energy (some experimental evidence)
 - Different of NASCAP \Rightarrow 0 below 50 eV
- Type of incident particle model:
 - If PIC: particle per particle
 - If fluid (Boltzmann): fluid backscattered flux

➤ Spectrum of backscattered electrons:

- Accommodation = 0.95
- Diffusive

➤ Need experimental inputs (in particular: experimental yield sums up secondaries and backscattered \Rightarrow ?)



Induced conductivity

➤ Simple NACAP approach:

- $\sim (\text{dose rate})^{\text{exponent}}$
- Still to be implemented (simple)

➤ Improved approach:

- Consider dose rate profile throughout the material (1D)
- Conductivity becomes:
 - Depth dependant (conductances in series)
 - With an improved dependence in dose rate history (memory effect)
- Will be implemented following experimental activity

The challenges of interaction modelling

➤ Challenges:

- Compute the interaction whatever the type of impinging flux (typically kinetic or fluid): polymorphism
- Flexibility and easiness to build new interactions

➤ Ideas of solutions:

- First approach: compute a function of a distribution from a function of a particle: ok e.g. for true secondary yield since individual particle characteristics can be lost (everything results in a 2eV-Maxwellian), but not for backscattering
- Capability to combine Interactor objects

➤ Exemple of application: secondary emission:

- True secondaries: everything summarised in a microscopic yield, that can also be applied to a fluid distribution through angle averaging
- Backscattered: a specific reflection interactor was developed, then added to the true secondary generator
- Possible extension with e.g. a more accurate model of backscattered electrons: define the microscopic yield $Y(E, \theta)$, which will be averaged for fluid impinging flux (and also for outgoing flux)

