Hints, Tips and Solutions

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Q. How do I model non standard materials, such as custom photoresists, when using the Monte-Carlo Implant simulator in ATHENA?

A. One of the more common questions regarding Monte-Carlo Implants, is the question of how to model a particular type of photo resist. There are numerous kinds in use and each have different stopping powers for ion implantation.

The question can be expanded into how to model any user defined material that is not in the *ATHENA* materials database, not just the narrower issue of photoresist.

The physical processes of implantation have very little to do with the chemical bonds of the target that is being implanted unless that chemistry has a direct effect on its exact crystalline structure, such as the case in Silicon Carbide for example. As a result, so long as the material being implanted has an amorphous structure, it's exact chemical bonding configuration can be ignored. The only properties of the target which are important are :-

1/ the fractional abundance of each of its constituent atoms,

2/ the atomic number of each of its constituent atoms,

3/ the atomic mass of each of its constituent atoms and

4/ the macroscopic average density of the material.

The following lines describe how to define silicon dioxide in *ATHENA* as a user definable material. There are a couple of reasons for using this as an example. Firstly it has an amorphous structure and secondly, we can check the validity of the user definable feature by comparing the results with the known *ATHENA* material, silicon dioxide.

The 3 lines of the input file below show how to define the relevant stages. The first line tells *ATHENA* that the material just deposited is user defined by the parameter "material=sand". If "sand" was a known *ATHENA* material, the syntax would be simply "sand", not "material=sand".

The next statement defines the physical properties of the user defined material, followed by a standard Monte-Carlo implant statement.
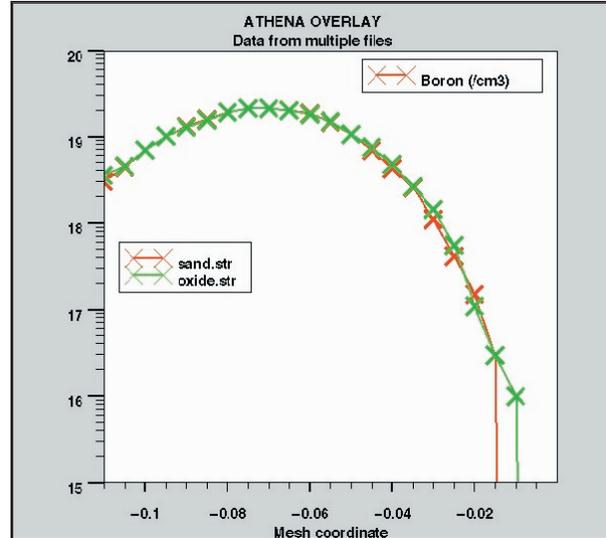

Figure 1 showing validation of the user definable material feature on the Monte-Carlo Implant statement in *ATHENA*.

```
deposit material=sand thick=0.11 div=22

material  material=sand  components=2  den-
sity=2.33 at.num.1=8 at.num.2=14 \

at.mass.1=16    at.mass.2=28    abund.1=0.6667
abund.2=0.3333

implant  boron  energy=10  dose=1e14  tilt=7
rotation=30 bca n.ion=10000
```

Figure 1 shows an overlay of boron implant profiles using the above set of statements and an identical input file using the known *ATHENA* material "oxide". The figure clearly shows identical material properties to within experimental error.