Using NPA data for sputtering estimations

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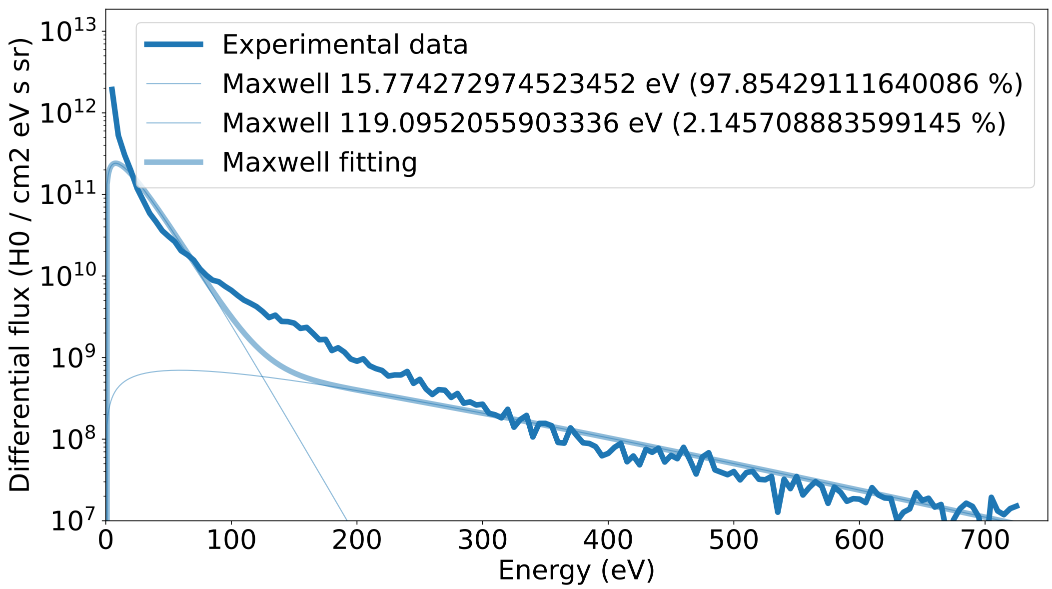

Figure 1: The differential flux is easy to transform into a quantity we want by multiplying it with certain system parameters

The erosion rate due to the neutrals can be estimated from a NPA measurement (an example of which is shown in figure 1) using the following formula:

$$S = \frac{2\pi}{N} \int_E Y(E)\mathcal{F}(E)\mathrm{dE} \tag{1}$$

With $Y(E)$ the yield of the gas on the material, $\mathcal{F}(E)$ the experimental differential flux and N the number density. This is quite straightforward to see as:

- The NPA covers a certain solid angle, this has been accounted for as can be seen in the unit of the example experiment (/sr meaning per steradian), we can get an approximation for the average flux in the vessel by assuming homogeneity and thus multiplying this data by 2π steradians.
- The differential flux in an energy bin causes sputtering, to get this sputtering rate we multiply by the yield Y as it's defined to be the outgoing atoms per incoming, we integrate over all energies to get the full contribution.

- The number density of the target N dictates how the amount of outgoing atoms relates to the decrease in thickness.

In the software we use equation 1 in the finite form, summing over the energy bins:

$$S = \frac{2\pi}{N} \sum_{E_0}^{E_{\max}} Y(E)\mathcal{F}(E)\Delta\mathrm{E} \tag{2}$$

Where we may get the yield $Y(E)$ using the software RustBCA[1] with parameters from Wolfgang Eckstein's book [2], assuming perpendicular impingement.

References

[1] Drobny J T and Curreli D 2021 *Journal of Open Source Software* **6** 3298 URL `https://doi.org/10.21105/joss.03298`

[2] Eckstein W 2013 *Computer Simulation of Ion-Solid Interactions* Springer Series in Materials Science (Springer Berlin Heidelberg) ISBN 9783642735134 URL `https://books.google.de/books?id=4h3rCAAAQBAJ`