

ImagingReso: A Tool for Neutron Resonance Imaging

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Software

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Summary

ImagingReso is an open-source Python library that simulates the neutron resonance signal for neutron imaging measurements. By defining the sample information such as density, thickness in the neutron path, and isotopic ratios of the elemental composition of the material, this package plots the expected resonance peaks for a selected neutron energy range. Various sample types such as layers of single elements (Ag, Co, etc. in solid form), chemical compounds (UO₃, Gd₂O₃, etc.), or even multiple layers of both types can be plotted with this package. Major plotting features include display of the transmission/attenuation in wavelength, energy, and time scale, and show/hide elemental and isotopic contributions in the total resonance signal.

The energy dependent cross-section data used in this library are from National Nuclear Data Center, a published online database. Evaluated Nuclear Data File (ENDF/B) (Chadwick et al. 2011) is currently supported and more evaluated databases will be added in future.

Python packages used are: SciPy (Oliphant 2007), NumPy (Walt, Colbert, and Varoquaux 2011), Matplotlib (Hunter 2007), Pandas (McKinney 2010) and Periodictable (Kienzle 2017).

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The neutron transmission calculation algorithm of neutron transmission $T(E)$, is base on Beer-Lambert law (Ooi et al. 2013; A. S. Tremsin et al. 2017; Zhang et al. 2017):

N_i : number of atoms per unit volume of element i ,

d_i : effective thickness along the neutron path of element i ,

$\sigma_{ij}(E)$: energy-dependent neutron total cross-section for the isotope j of element i ,

A_{ij} : abundance for the isotope j of element i .

For solid materials the number of atoms per unit volume can be calculated from:

NA : Avogadro's number,

C_i : molar concentration of element i ,

$$T(E) = \frac{I(E)}{I_0(E)} = \exp\left[-\sum_i N_i d_i \sum_j \sigma_{ij}(E) A_{ij}\right]$$

Figure 1

$$N_i = N_A C_i = \frac{N_A \rho_i}{\sum_j m_{ij} A_{ij}}$$

Figure 2

i : density of the element i ,

m_{ij} : atomic mass values for the isotope j of element i .

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