

HTML/JavaScript Electron Range Approximation Tool

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1 Overview

This document provides documentation and instruction for the HTML/Javascript range approximation tool developed by Utah State University’s Materials Physics Group. The model used is described in [Wilson, 2010;Starley, 2016]. The *HTML/JavaScript* webpage is an online tool which calculates the electron range for 246 NIST materials as well as any number of custom materials. The webpage consists of two different pages, the *Supporting Documents* and the *Electron Range Approximation Tool* page.

2 Supporting Documents

The *Supporting Documents* page includes the version number at the top of the page following by documentation for the two range tools, relevant downloads, and relevant references.

2.1 Documentation

The *Documentation* section includes two downloaded pdf files that discuss the operation of the two range tools, one of which is this document.

2.2 Downloads

The *Downloads* section includes the Microsoft Excel Range Approximation Tool along with other relevant downloads such as the Material Database.

2.3 References

The *References* section includes the main article to reference both of the Electron Range Approximation tools, along with other relevant references. To begin using the tool, a user selects the desired material by clicking the *Material* drop-down box as shown in Fig. 3. Next, click the *Add Material* button to the right of the drop-down box to add the material to the *Material Table* and the graph. To add multiple materials, simply select another material from the drop-down box and click the *Add Material* button again. This can be done for any number of materials.

3 Electron Range Approximation Tool

The *Electron Range Approximation Tool* page consists of several different parts that allows users to select the data to output and several input boxes for user control.

To begin using the tool, a user selects the desired material by clicking the *Material* drop-down box as shown in Fig. 3. Next, click the *Add Material* button to the right of the drop-down box to add the material to the *Material Table* and the graph. To add multiple materials, simply select another material from the drop-down box and click the *Add Material* button again. This can be done for any number of materials.

The *Material Table* (see Fig. 4) shows the currently graphed materials, along with their key material parameters. The *Legend* column of the *Material Table* allows users to customize the color of the trace of a specific material. The *Remove Material* buttons allows users to either remove a specific material by clicking the corresponding *Remove* button or remove all materials by clicking the *Remove All* button in the header row.

After one or more materials are added to the table and graph, the desired energy range can be customized by changing the *Energy Min (eV)*, *Energy Max (eV)*, and *Energy Steps* buttons. You can also select whether the energy steps are linearly or logarithmically spaced by checking or unchecking the *Log (E)* checkbox. The range of energies that are applicable for this model is ~ 10 eV to $\sim 10^7$ eV. If you select energies outside of this range, the input box will be outlined in red and a warning will popup. The number of energy steps can also be configured, but should generally be less than 10^5 points or the webpage may become unstable. The vertical range axis of the graph can also be changed between linear and logarithmic by unchecking or checking the *Log (R)* checkbox.

3.1 Custom Materials

To input a custom material with the *HTML/JavaScript* online tool, first select *Custom* in the *Material* drop-down box found at the top of the material list. A set of input boxes will appear (see Fig. 5) to input the required material properties. The *Material Name* and *Formula* are entered as text, whereas the other inputs are numeric.

Material \bar{Z}_A and *Material \bar{M}_A* can both be automatically calculated by clicking the *Calculate* button to the right of *Material \bar{Z}_A* . This opens a popup window, as shown in Fig. 6. To use this calculator, click on the cell in the periodic table corresponding to an element or isotope listed in the chemical formula and enter the number (or fraction) of atoms for the given element; repeat this for all the elements/isotopes in the material formula. To remove an element from the calculation, simply click on the element and enter 0. When all elements/isotopes are entered, click on the *Ok* button at the bottom right of the popup. Scroll down or maximize the popup window if you cannot see the *Ok* button or some elements are not visible in the popup window. Alternately, you can click the gray area outside the popup to close the calculator and enter the values manually.

To have the *HTML/JavaScript* online tool automatically calculate N_v^{pre} using the predicted method enter 0 in the input box for N_v .

Once all the custom material properties have been entered, click on the *Add Material* button to insert it into the list for analysis and graphing. You can repeat the procedure to add additional custom materials.

3.2 Data Export

After selecting the desired materials to graph, the data can be output in several formats using the three export buttons located directly above the graph. The *Material Table Export* method exports the *Material Table* as a tab-delimited text file. The *Export Graph* method exports the graph as a .png image file. The *Export Data* method exports the range data as a tab-delimited text file that can be imported into *Microsoft Excel* or other analysis or graphing programs compatible with tab-delimited text files.

4 References

Gregory Wilson, Anne Starley, and JR Dennison, "Electron Range Computational Tool for Arbitrary Materials over a Wide Energy Range," 15th Spacecraft Charging Technology Conference, Kobe University, (Kobe, Japan, June 25-29, 2018).



Anne Starley, Gregory Wilson, Lisa Phillipps and JR Dennison, "Predictive Formula for Electron Penetration Depth of Diverse Materials over Large Energy Ranges," Proceedings of the 14th Spacecraft Charging Technology Conference, Space Research and Technology Centre of the European Space Agency (ESA/ESTEC), (Noordwijk, Netherlands, April 4-8, 2016), 2 pp.



Gregory Wilson and JR Dennison, "Approximation of Range in Materials as a Function of Incident Electron Energy," Proceedings of the 11th Spacecraft Charging Technology Conference, (Albuquerque, NM, September 20-24, 2010), 6 pp.