TITLE
Experimental electron scattering data: web interface for updating and graphical presentation

SHORT RUNNING TITLE
Experimental electron scattering data

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SUMMARY

INTRODUCTION

In recent years a large data base has been collected from many experimental results on various aspects of electron-solid interactions (Joy 1995, Joy 2006). Measured parameters include stopping powers, backscattered and secondary electrons, with the general format of the data being a series of measurements for a specific parameter as a function of beam voltage.

This data, assembled from published sources, has provided useful observations on the variation of measured parameters as a function of beam voltage, and also of the spread in values measured for the same parameter by different authors. These data are used in X-ray microanalysis correction procedures, widely available in routine SEM work.

Another application for this collection of experimental values is their comparison against the output from Monte Carlo simulation programs as backscattering and secondary electron coefficients can be easily calculated. In this way, one aspect of the "correctness" of the simulation can be accessed, and the usefulness of the application of various algorithms in the calculations can be compared.

The database was originally created as a text document in Word format, with lists of data for the various parameters from all the references available.

In 2001, all available data in the text document was used to create graphical plots and these were put on the internet. This amounted to hundreds of pages and images, which gave a snapshot of the variation of each scattering parameter for each material or compound. The old system is still available on the internet (Napchan 2006), along with a full description on how it was created.

Although the above approach provided a more accessible view of the data available, it had its limitations. It was not easily updatable, requiring the complete regeneration of all pages and graphs if the database content changed, and the creation of a graphic view of some parameter was not flexible enough for example to compare data for two materials or compounds.

NEW SYSTEM

The goals in creating the new on-line system, now available on-line (Napchan 2006), have been:

1. Create a relational database structure to hold the data, and which will facilitate both its display and modification.

2. Display the data in graphical format, to allow visualization of trends for the various parameters, as a function of beam accelerating voltage, as well as comparison between different sources for the same parameters. It also allows an easier comparison between data for specimens of different compositions.

3. Make the original data easily web accessible.

4. Allow adding additional data points, and in general, comments about the available data. This additional data is to be checked before being included in the database and used for displays and comparisons.

As a first step to achieve the aims above, the experimental data was organized in a set of relational database tables, using the current text version of the database (Joy 2006). Fig. 1 displays the various tables that contain all the experimental electron scattering data, and shows the relational links between them.

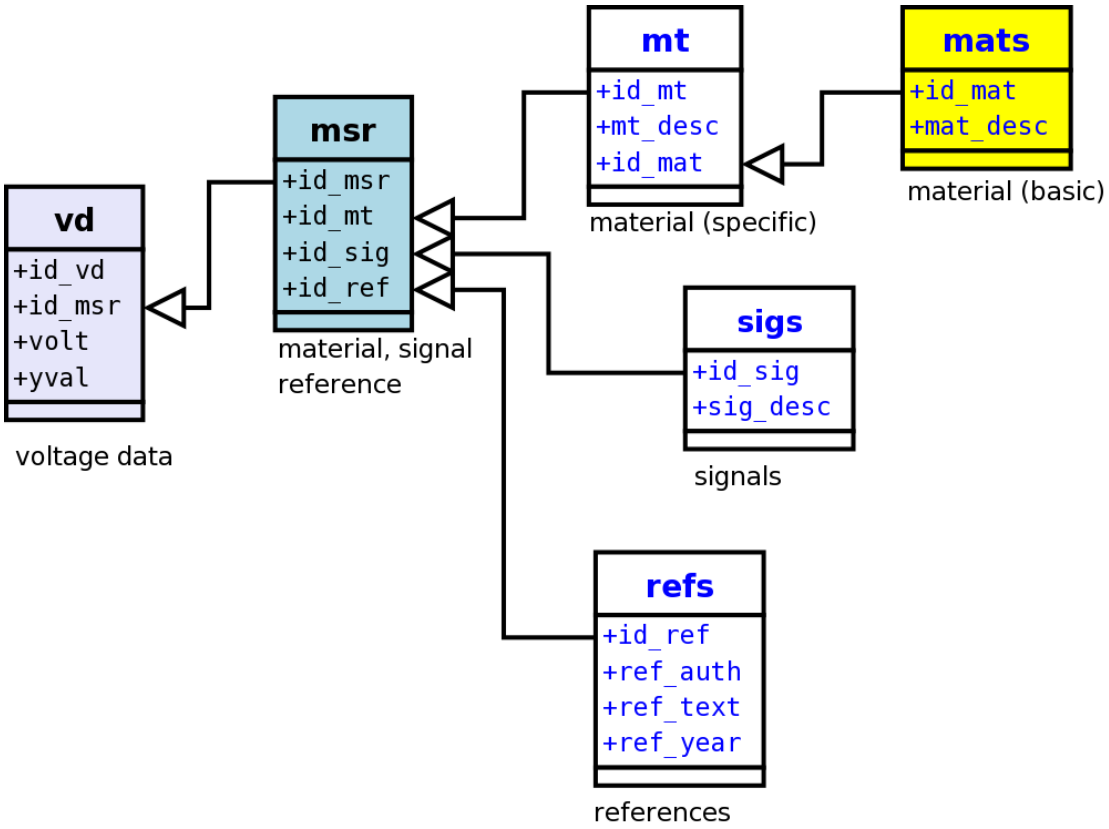


Fig. 1: Table names, structure and relational links

The feature common to all tables is to have an unique index field for each row, which is linked to similar indexes in other tables. To each record in table msr corresponds a line plot. To each mat table row correspond at least one row in the mt table: if the basic material is Silicon, the corresponding specific materials could be amorphous, crystalline or any other particular type of Silicon.

The basic functions provided by the system are to graph, view and add experimental data.

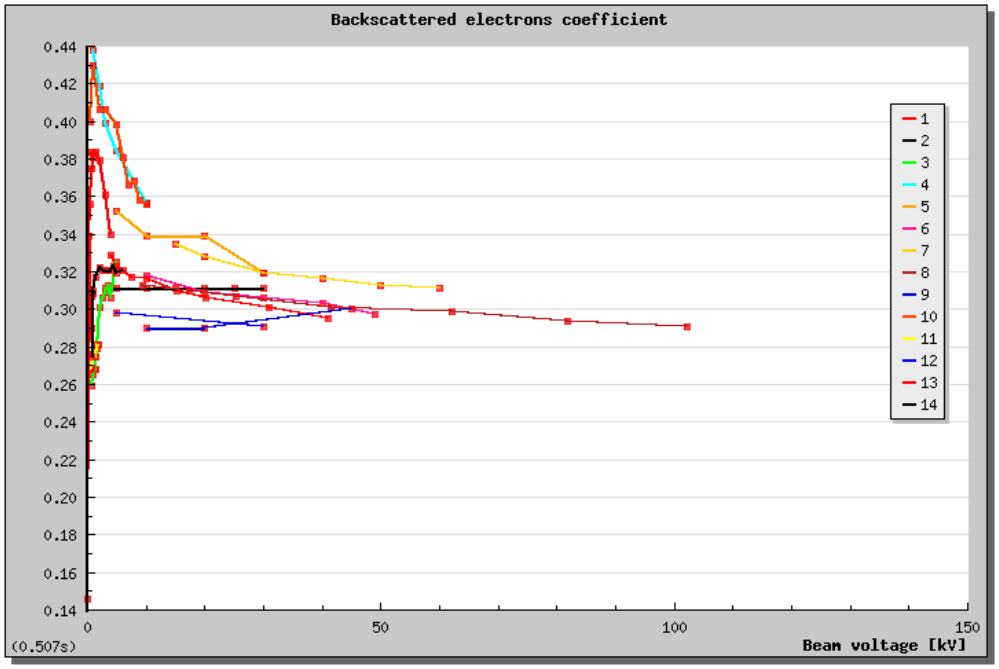
To graph the experimental data it is necessary to select the type of signal required (backscattered, secondary or stopping power) and one or more specific materials (for which there is data for the selected signal, done automatically when selecting the signal). A further function available when graphing the data is designed to create lists of the raw data used for the plots included in the graph (data from the vd table for the corresponding msr index).

An additional web page allows to view the lists of data available, with the various indexes expanded to the description of the corresponding items. In this page, it is possible, for example, to view a list of all the datasets for a selected signal, by listing all records in the msr table.

Adding datasets (plots) to the experimental data is done in two steps. First, the submitter emails the information using an on-line form to collect the required fields. After checking, this information can be manually added to the database tables, creating the necessary indexes manually.

RESULTS
The following images provide some examples of the output produced by the system. Fig. 2 shows the results from all available references for the backscattering coefficient for copper. Following the graph, the various references to the sources of the data are listed.

Experimental electron scattering data



ViewDataPoints
ViewGraphOnly

References

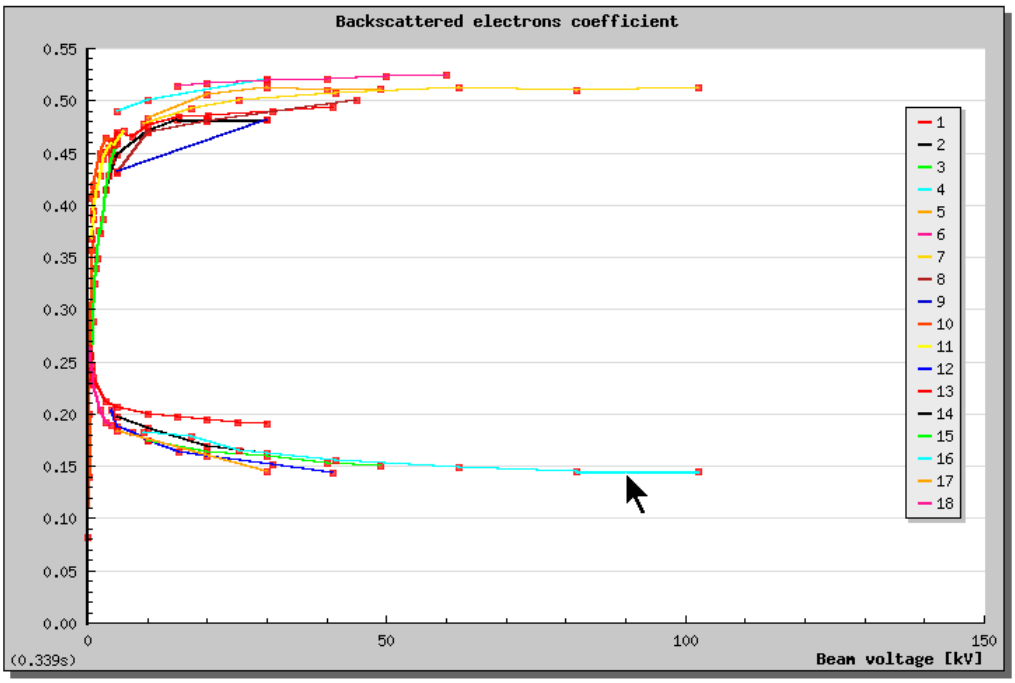
Z=29 Copper

1 Hunger H-J, Kuchler L,*phys.stat.sol., (a) 56 , K45.* 1979
2 Reimer L, Tolkamp C,*Scanning 3, 35..* 1980
3 Moncrieff D A, Barker P R,*Scanning 1, 195.* 1976
4 Shimizu R,*J. appl. Phys 45, 2107.* 1974
5 Bishop H E,*Ph D Thesis, Cambridge.* 1963
6 Heinrich K F J,*Proc. 4th Conf. on X-ray Optics and Microanalysis, ed R Castaing et al , (Hermann:Paris), p159.* 1966
7 Neubert G and Rogaschewski S,*phys. stat. sol. (a) 59, 35.* 1980
8 Drescher H, Reimer L and Seidel M,*Z. angew. Physik 29, 331.* 1970
9 Cosslett V E and Thomas R N,*Brit. J. Appl. Phys: J. Phys D 16, 774.* 1965
10 Koshikawa T and Shimizu R,*J. Phy. D. Appl. Phys. 6, 1369.* 1973

Fig. 2: Experimental electron backscattering coefficient for Copper

Fig. 3 shows all backscattered electron data for Gold and for Silicon, probably the two most studied materials. Apart from the variation between the measurements within each material, a clear different trend is observable for the variation of the backscattering coefficient with decreasing beam accelerating voltage.

Experimental electron scattering data



ViewDataPoints
ViewGraphOnly

References

Z=79 Gold

1 Hunger H-J, Kuchler L,*phys.stat.sol., (a) 56 , K45.* 1979
2 Reimer L, Tolkamp C,*Scanning 3, 35.*. 1980
3 Bongeler R, Golla U, Kussens M, Reimer L, Schendler B, Senkel R, Spranck M,*Scanning 15, 1.* 1993
4 Bishop H E,*Ph D Thesis, Cambridge.* 1963
5 Heinrich K F J,*Proc. 4th Conf. on X-ray Optics and Microanalysis, ed R Castaing et al , (Hermann:Paris), p159.* 1966
6 Neubert G and Rogaschewski S,*phys. stat. sol. (a) 59, 35.* 1980
7 Drescher H, Reimer L and Seidel M,*Z. angew. Physik 29, 331.* 1970
8 Cosslett V E and Thomas R N,*Brit. J. Appl. Phys: J. Phys D 16, 774.* 1965
9 Wittry D B,*Proc. 4th Conf. on X-ray Optics and Microanalysis, ed R Castaing et al , (Hermann:Paris), p168.* 1966
10 Bronstein I M, and Fraiman B S,*in 'Vtorichnaya Elektronnaya Emissiya', (Nauka: Moskva), p340.* 1969
11 El Gomati M M, and Assad A M D,*Proc. 5th European Workshop on Microbeam Analysis, (in press).* 1997

Z=14 Silicon

12 Hunger H-J, Kuchler L,*phys.stat.sol., (a) 56 , K45.* 1979
13 Reimer L, Tolkamp C,*Scanning 3, 35.*. 1980
14 Bishop H E,*Ph D Thesis, Cambridge.* 1963
15 Heinrich K F J,*Proc. 4th Conf. on X-ray Optics and Microanalysis, ed R Castaing et al , (Hermann:Paris), p159.* 1966
16 Drescher H, Reimer L and Seidel M,*Z. angew. Physik 29, 331.* 1970
17 Wittry D B,*Proc. 4th Conf. on X-ray Optics and Microanalysis, ed R Castaing et al , (Hermann:Paris), p168.* 1966
18 Bronstein I M, and Fraiman B S,*in 'Vtorichnaya Elektronnaya Emissiya', (Nauka: Moskva), p340.* 1969

CONCLUSION
Despite the large body of information that has been collected, significant gaps exist both in relation to specimen materials and beam accelerating voltages for which data is available. This is particularly true for low accelerating voltages, that became more popular with the equipment developments in the last few years, and, for new combinations of materials such as mixed types of

semiconductors (for example, the database does not have values for GaN). Even for materials that are widely investigated at "standard" operating conditions, the literature values from different authors vary by as much as 30%.

The new database system replaces hundreds of web pages with a set of relational database tables holding the data and a few server scripts that process the data and create the required graphic views.

Using the new system described above, the experimental electron scattering data can be plotted in real-time, after selection from various possible options. New data can be easily inserted, and comments made (to the authors) about existing data.

By providing a system with the above features it is hoped that the database becomes a real-time repository with the most recently available information, and which will eventually lead to better defined values for the various parameters.

FUTURE WORK

While the system in its current is usable, there are various improvements that can be affected:

- Check the data in the system correct various spelling mistakes, improve the user interface.
- To make it easier to submit data for inclusion in the database we could allow submission of graphical experimental data for digitization, not just data point pairs.
- Adding to the on-line datasets other electron scattering related experimental parameters, such as X-ray ionization cross-sections, already present in the original database. The present structure will make this addition relatively easy to be carried out. Add comments about how the datasets were obtained, such as experimental conditions and other comments.
- Transfer to a more institutional web hosting site, perhaps making the finding of the data by interested researchers easier. This could also give improved performance.
- Allow more control on the look of the produced graphs: allow selection of axis limits and references.

REFERENCES

Joy DC: "A Database on Electron-Solid Interactions", SCANNING Vol. 17, 270-275 (1995)

Joy DC: "A Database of Electron-Solid Interactions", Revision 04-02, The complete database, containing tabulations of all available data sets as well as a comprehensive bibliography, can be downloaded as a Microsoft Word document from http://web.utk.edu/~srcutk/htm/interact.htm (2006)

Napchan E: "Database of Electron-Solid Interactions", http://www.mc-set.com (2006)