DESIGN AND IMPLEMENTATION OF A MICROWAVE PACKAGING MATERIALS DATABASE

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Abstract **– A microwave packaging materials database is designed and implemented to enable materials tolerant microwave packaging design. Over 200 products covering 14 different packaging applications are included in this "stand-alone" application that requires no additional host software. Advanced search routines permit designers to select packaging materials based on a combination of materials properties. Use of this database reduces design cycle time and non-recurring (NRE) engineering cost and can expedite the insertion of new materials into microwave packaging design.**

I. Introduction

Advanced microwave modules are extremely complex microwave hybrid assemblies containing many types of organic and inorganic materials that have been chosen as a result of very specific materials properties. In 1993, a Special Technology Area Review (STAR) on Microwave Packaging concluded that there is a lack of comprehensive databases and data models for microwave packaging materials. They concluded that the microwave properties of many materials that are used in packaging are unknown or poorly documented.

The microwave materials database described in this paper was developed in response to the STAR findings as a part of the DARPA supported High Density Microwave Packaging Program (HDMP). Many of the features of the database were recommended by other HDMP program members that are major MCA suppliers. Design and organization of the database are discussed, followed by a discussion of the features and operation. Data collection and dissemination are reviewed and connectivity of the database to other CAD tools is discussed.

II. Design

Figure 1 is an initial classification of the basic microwave packaging materials that was formulated to guide the design of the database program [1]. Materials having similar properties are grouped together and should have the same data fields in the database program. Organic materials were once prohibited from use in military microcircuits. Today, however, the advantages of these materials for certain applications and a better understanding of their reliability implications have resulted in a renewed interest in these materials.

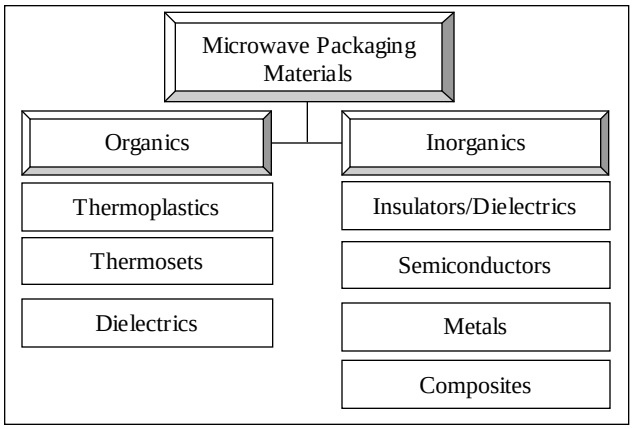

Figure 1. Microwave Packaging Materials Classification

Material properties are organized in specific categories consistent with recommendations

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in the STAR Report on Microwave Packaging Technology [2]. These categories include mechanical, metallurgical, thermal and electrical. Figure 2 is a diagram of the organization of materials properties showing the categories and key properties within each category [3].

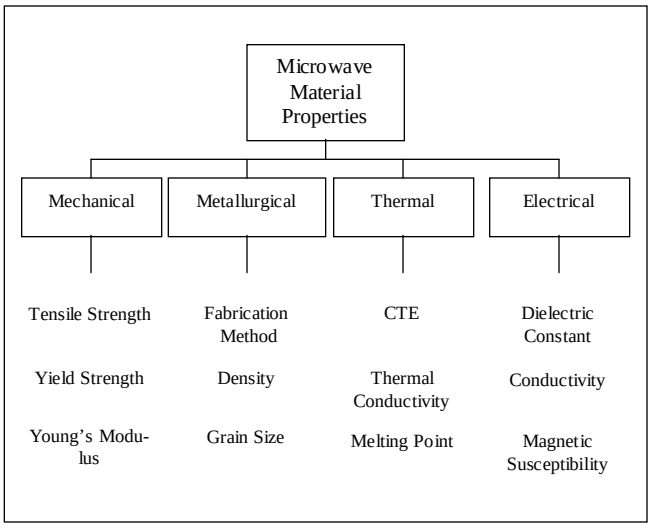

Figure 2. Microwave Materials Properties Organization

Efficient access to and manipulation of the data requires a well-planned schema. Figure 3 shows the table relationships that were developed to enhance data entry as well as application operation. The Product table is linked to the Properties, Spreadsheet and Supplier tables. At the next higher level, the Material Products table is connected to the Products, Suppliers, Materials and Application Material tables.

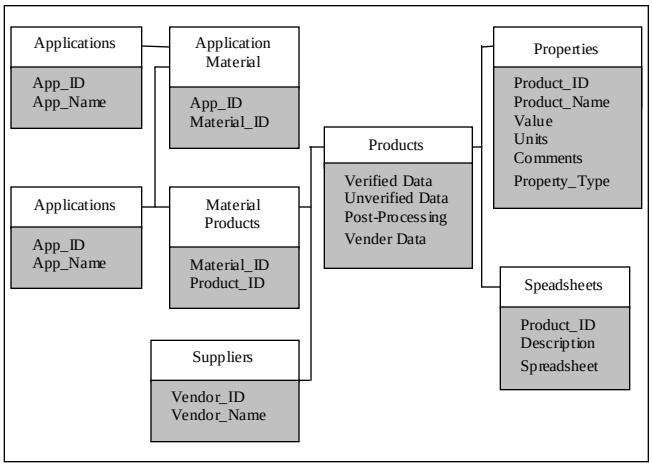

Figure 3. Microwave Materials Database Schema

A Windows®-based platform was selected in order to make the database accessible to the greatest number of users. Initially, this decision was viewed as a trade-off between widespread use and speed. However, today's high performance PCs offer workstation speeds at much lower cost and the rapid growth in the number of Windows NT systems validates our decision.

Visual Basic® was the programming language used to develop the database application. This approach permitted the inclusion of a high level graphical interface. Microsoft Access® database engine is the heart of this application. Use of Access® as the database engine allows for direct interface with Excel® for data analysis and Word® for documentation purposes. This also permits the application to be completely self-contained. The user is not required to provide Access® or any other software. Excel® is required to use the advanced spreadsheet feature of the database.

Information contained within the database is organized in a clear and concise way. Material properties are the basis of the database. There are currently 81 properties associated with over 200 products contained within the database. Properties are further divided into mechanical, electrical, metallurgical and thermal categories. Each product has specific associated properties. Tables, plots of data and graphs that are associated with the products are stored within the database as Excel® spreadsheets. This feature enables graphical representation of properties that vary with frequency or temperature.

Association of material properties and graphs with the specific materials is an important first step; however, the microwave materials database has achieved much more than that. Each of the products is grouped according to its material type. Materials are further classified according to the applications in which they are normally used. This allows a junior designer, with little experience, to begin packaging design using known materials for a particular application. Another powerful feature, discussed in the operation section, is the query function.

Georgia Tech maintains the database and routinely adds new products. However, in some cases, users may wish to store proprietary data that they have measured on their own. This application

allows users to build their own custom database that is maintained separately from the standard database. User-created databases are not affected by updates to the standard database.

III. Operation

The microwave packaging materials database application was designed to provide a single, easily accessible source of critical data for microwave designers. By selecting the Search pull-down menu within the database, it is possible for a user to search the information contained in several different ways. Figure 4 is a depiction of the screen the user sees when a search by application, material, or product is selected from the Search pull-down. From this menu, it is possible for the user to search the database for specific products, a specific type of material, or even materials associated with a specific application within the microwave packaging field.

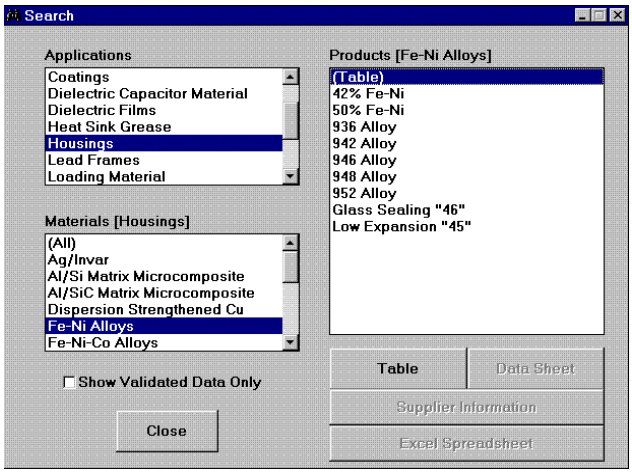

Figure 4. Search Box

One of the most powerful features that has been incorporated into the HDMP database is the Query. Using this feature, it is possible to search the database for products that are a particular material or are used in a specific application. It is also possible to search the database for products that have any combination of property value ranges. Up to six properties, along with material and application can be used to execute the Query. Figure 5 is a depiction of the dialog box that the user sees when Query is selected from the Search pull-down. Once the parameters of the Query have been set, the user clicks on the Execute Query button and a list of products that match the search is shown in the field in the lower left corner of the screen.

To view information about any of the

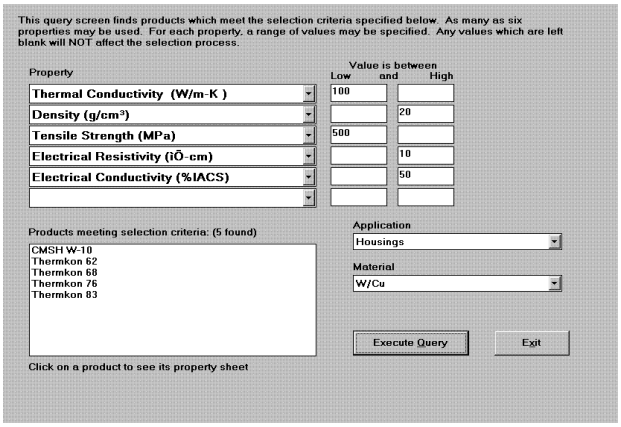

Figure 5. Sample Query Box

products found, the user double clicks on that product. Figure 6 is the product information screen that the user sees after selecting a product of interest. The user can obtain general information as well as supplier information about the product by selecting View next to the product name. The user can see more detailed information on a particular property of the material by highlighting the property and selecting View next to the properties. The user can also see spreadsheets associated with the product by highlighting the spreadsheet of interest and selecting View.

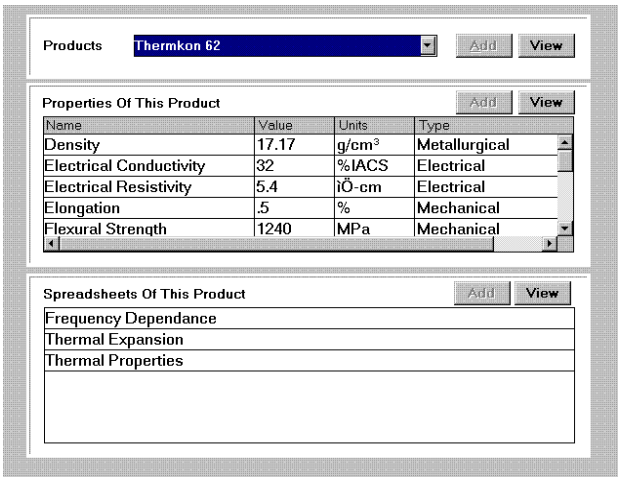

Figure 6. Product Information System

Spreadsheets are used to express temperature and frequency dependent properties. This capability allows the user to view Microsoft Excel spreadsheets that are associated with a particular product. From the Search screen, shown in Figure 4, the user can access the spreadsheets associated with a product by highlighting the product and then selecting the Excel Spreadsheet button.

IV. Distribution

Diskette has been the predominant means to distribute initial copies of the database. New users are sent a set of three diskettes that contain the compressed files and an installation program. The database is installed by inserting the first diskette into the disk drive and executing the setup program.

Once a user has the program running on their machine they only require single diskette updates which contain a compressed version of the latest data file and executable file along with a decompression program to expand the files. Once the files are expanded, the user simply replaces the older executable and data files in the database directory with the new ones and uses the program normally. This method of database distribution and update has been the most used approach to date. Thirty-three (33) people, representing 25 companies, are currently using the HDMP database.

An FTP (File Transfer Protocol) site has been established to provide access to frequently updated data. The FTP site contains the most recent data file, executable file, and a text document for installation instructions. The site is accessible using the World Wide Web or any FTP program currently on the market. The address of the site is 'ftp://hdmp.gtri.gatech.edu'. The current site allows anonymous users to login using their e-mail address as a password. The site does not currently contain a complete version of the database program and is used strictly for updates by registered users.

As an additional option, a Web site was created to provide easy access to the most recent files and information on the program in general. The Web page is accessible using any of the newer Web browsers. It is not possible to view the Web page using a text only browser. The address for the Web page is 'http://eoeml-www.gtri.gatech.edu /home/hdmp/index.htm'.

V. Connectivity

In an integrated microwave packaging design environment, materials properties are needed in the EM and thermal simulation tools. Ideally these tools would be linked to a central layout tool. Changes in layout could be simulated without the need to re-enter information directly into the simulation tool. This integrated environment is evolving through Phase I of the MAFET program; however, seamless integration of the database into a 3-D EM simulator was a goal in the development of this application. Hewlett-Packard's High Frequency Structure Simulator (HFSS) was chosen for this demonstration. An electronic link from the database to HFSS was successfully demonstrated on two examples including a lowpass microstrip filter structure and a flip-chip interconnection with coplanar waveguide (CPW). A single substrate (alumina) with bumped interface to the CPW transmission line was used in the simulation.

VI. Conclusions

A user friendly, microwave materials database has been designed and implemented to enhance microwave packaging design. Features in the database make it easy for designers to optimize material choices.

Acknowledgements

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References

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[3] ASTM Standards on the Building of Materials Databases, ASTM, First Edition, 1993.