CINDAS: Microelectronics Packaging Materials Database Guide

2006

Guide to Discovery

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CINDAS: Microelectronics Packaging Materials Database (MPMD)

10 Reasons to Use CINDAS: Microelectronics Packaging Materials Database

1. Access to properties of over 750 materials and over 15,000 data curves
2. Identify and assess the appropriateness of materials for engineering and other applications
3. Graph multiple materials and data sets/conditions for comparison
4. Data Visualization (data curves) expedites analysis and materials selection
5. Data is reviewed and processed by Materials experts
6. Updates occur regularly, and coverage dates back to the 1900s
7. Advanced searching capability of 5 indexed fields
8. Ability to cross-search with other CSA Illumina databases including *CINDAS: Thermophysical Properties of Matter Database (TPMD)*
9. Value-added tool streamlines the critical research development process and saves computation time
10. CINDAS is reliable, flexible and critically evaluated

What Is CINDAS: Microelectronics Packaging Materials Database and Why Should I Use It?

The *CINDAS: Microelectronics Packaging Materials Database* (MPMD) contains data on thermal, mechanical, electrical and physical properties of electronics packaging materials. This database which contains properties of over 750 materials and contains over 15,000 data curves was developed under the sponsorship of the Semiconductor Research Corporation. The database is searchable by material group, material name, property group, property name and independent variable. For all data curves, the material composition, experimental conditions, raw or smoothed data, and references are given. These references may be to published literature, theses, or technical and laboratory reports. Dynamic graphing capabilities allow users to compare the same property of multiple materials or the same material under different conditions, as well as change the ranges on the graph axes.

MPMD is produced by CINDAS LLC. For more than 45 years, the Center for Information and Numerical Data Analysis and Synthesis (CINDAS) at Purdue University has managed a comprehensive and systematic research program on the properties and behavior of materials. This research program involves basic and applied research, using both experimental techniques and data from relevant worldwide scientific and technical literature. The end result is the compilation, critical evaluation, correlation, and synthesis

of both existing and new experimental data to produce reliable reference data (recommended values), as well as the generation of estimated values to fill data gaps. CINDAS also produces a "companion" database to MPMD called the *Thermophysical Properties of Matter Database* (TPMD).

On CSA Illumina, MPMD can be searched as a stand alone file or, alternatively, it can be accessed via a search of CSA databases that contain related materials science records, such as the *CINDAS: Thermophysical Properties of Matter Database* (TPMD) and the *CSA Technology Research Database* (TRD).

Microelectronics Packaging

Microelectronics packaging is the design and assembly of microelectronic components into packaged assemblies that perform one or more functions. A typical example would be the various circuit boards in a computer. MPMD contains data on a large portion of the solders, adhesives, coatings, etc. used in this industry.

CINDAS Data Curves

A CINDAS data curve is essentially a graph. It is a visual representation (a plotting) of a table of data illustrating the response of a property with incremental changes – usually with a dependent and independent variable. The line connecting the plotted data points can be curvilinear or rectilinear but most often is curved

The independent variable (e.g. Temperature (deg. K)) is usually plotted on the horizontal "X" axis. The dependent variable (e.g. expansion or contraction of the material being tested) is plotted on the vertical or "Y" axis. A data point is that point in the matrix where a specific temperature gives a specific expansion or contraction.

Dependent and independent variables would be used, for example, in plotting the height of individuals on a crowded bus. The horizontal (X) axis plots the independent variable. In this case, it is height in increments of feet/meters. It is independent because we chose it. The vertical axis (Y) would be the number of individuals that represent that height which meets the parameters given in the horizontal axis.

One curve could represent individuals, or two curves could represent women and men with a third representing children, etc. Multiple data curves are displayed in different colors.

Major Material Groups Covered

- Elements
- Metal Alloys
- Solders - Leaded
- Solders - Lead Free
- Intermetallics, Miscellaneous
- Intermetallics, Aluminides
- Intermetallics, Beryllides
- Intermetallics, Silicides
- Ceramics - Oxides
- Ceramics - High K Oxides
- Ceramics - Nitrides, Silicides, Carbides,...
- Molding Compounds
- Encapsulants and Underfill Materials
- Adhesives
- Coating and Unfilled Epoxies
- Polymers - Polyimides
- Polymers - Others
- Composites - Thermal Management
- Composites - Laminates
- Semiconductors
- Liquids & Gases

Properties Covered

Thermophysical Properties:

- Coefficient of Thermal Expansion
- Coefficient of Thermal Expansion (Z)
- Contact Angle
- Cross-Linking Density
- Cure Degree
- Cure Temperature
- Curie Temperature
- Density
- Glass transition Temp (Master Curve)
- Glass Transition Temperature
- Interfacial Tension
- Liquide Temperature
- Mean Coeff. of Thermal Expansion
- Mean Coeff. of Thermal Expansion (Z)
- Molar Heat capacity
- Reflectance
- Relative Density
- Softening Temperature
- Solidus Temperature
- Specific Heat Capacity
- Surface Tension
- Thermal Conductivity
- Thermal Conductivity Film
- Thermal expansion

- Thermal Expansion (Z)
- Thermal Expansion Percent
- Thermal Impedance
- Thermal Resistance
- Thermal Resistance Junction – Heat Sink
- Viscosity

Electrical Properties:

- Attenuation
- Coefficient of Electrical Resistivity
- Dielectric Constant
- Dielectric Loss Index
- Dissipation Factor
- Electrical Conductivity
- Electrical Resistivity
- Electrical Resistivity, Film
- Electrical Resistivity, ohm m
- Insulation Resistance
- Leekage Conductance
- Permittivity
- Piezoelectric Constant
- Piezoresistance Coefficient
- Relative Electrical Resistance
- Seebeck Coefficient
- Surface Resistivity
- Volume Resistivity

Mechanical Properties – Modulus:

- Bulk ModulusGPa
- Bulk Modulus, MPa
- Compressive Modulus, GPa
- Compressive Modulus, MPA
- Dynamic Shear Modulus
- Dynamic Young's Modulus
- Elastic Modulus (out-of-Plane)
- Flexural Modulus
- Flexural Modulus, MPa
- Loss Modulus
- Relaxation Modulus
- Relaxation Modulus (master Curve)
- Young's Modulus, GPa
- Young's Modulus, MPa

Mechanical Properties – Strength:

- Bend Strength
- Biaxial Flexural Strength, Ultimate
- Compressive Strength, Yield
- Die Shear Strength
- Flexural Strength
- Fracture Strength
- Lap Shear Strength
- Shear Strength
- Shear Strength, Yield
- Tensile Strength, Break
- Tensile Strength, Ultimate
- Tensile Strength, Yield
- Yield Strength, Flexural

Mechanical Properties – Stress:

- Biaxial Stress
- Biaxial Stress, Yield
- Compressive Lower Yield Stress
- Compressive Stress
- Compressive Stress, True
- Critical Resolved Shear Stress
- Cure Stress
- Elastic Flexural Limit
- Film Stress
- Flexural Stress
- Flow Stress
- Residual Stress
- Shear Stress
- Stress Relaxation
- Tensile Stress
- Tensile Stress, True
- Tensile Upper Yield Stress
- Thermal Stress
- Transverse Rupture Stress

Mechanical Properties – Hardness:

- Brinell hardness
- Knoop Hardness
- Microhardness

- Rockwell A Hardness
- Rockwell hardness
- Shore hardness
- Vickers Hardness
- Vickers Hardness, HV

Mechanical Properties – Fatigue:

- Fatigue Life
- Fatigue Stress
- Fatigue, Bend Strain Range
- Fatigue, Load Drop
- Fatigue, Maximum Stress
- Fatigue Shear Strain Range
- Fatique Shear Stress Range
- Fatigue, Stress Amplitude
- Fatigue, Stress Amplitude Change
- Plastic Strain Range

Mechanical Properties – Creep:

- Compressive Creep Strain, True
- Creep Compliance
- Creep Life
- Creep Plastic Strain
- Creep Rate, Compressive
- Creep Rate, Flexural
- Creep Rate Tensile
- Creep Strain
- Creep Strain Rate
- Creep Strain Rate, True
- Creep Strain, Compressive
- Creep Strain, Tensile
- Creep Strrain, True
- Creep Strength, Tensile
- Creep, Applied Stress
- Creep, Normalized Shear Strain Rate

Optical Properties:

- Absorbance
- Birefringence
- Extiction Coefficient
- Normal Spectral Emissivity
- Normal Total Emissivity
- Refractive Index

Mechanical Properties – Other:

- Adhesion
- Adhesion Strength
- Biaxial Strain
- Burst Pressure
- Compressibility
- Compressive Plastic Deformation
- Compressive Strain
- Compressive Strain at Fracture
- Crack Growth rate
- Crack Growth Rate (da/dn)
- Crack Length
- Elongation
- Elongation at Break
- Elongation at Yield
- Film Strain
- Flexural Strain at Fracture
- Fracture Energy
- Fracture Toughness, K(lc)
- Impact Energy
- Load
- Loss tangent (tan delete)
- Mechanical Loss Factor
- Normal Strain
- Peel Strain
- Plastic Strain
- Plastic Strain at Fracture
- Poisson’s Ratio
- Reduction of Area
- Relaxation, Stress Remaining

Other Properties:

- Activation Enthalpy
- Coefficient of Friction
- Composition
- Corrosion Mass Loss
- Cure Schedule
- Cure Time
- Diffusion Distance
- Diffusion Energy, Grain Boundary

- Dissolution of Nickel
- EMMI Spiral Flow
- Failure Probability
- Film Thickness
- Film Thickness Retention
- Flow Time
- Gel Time
- Grain Size
- Intermetallic Grain Radius
- Intermetallic Grains Density
- Intermetallic Thickness
- Intermetallic Total Grains Volume
- Lifetime
- Linear Shrinkage
- Linear Swelling
- Mass Diffusion Coefficient
- Moisture Content
- Molding Time
- Oxidation Rate
- Oxide Thickness
- Pore Size

Searchable Field Codes Available in CINDAS: Microelectronics Packaging Materials Database

Field Name	Label	Search Examples
Independent Variable	IA=	Strain rate
Material Group	MG=	Encapsulants
Material	ML=	Silica
Property	PP=	Young's Modulus
Property Group	PG=	Mechanical

Boolean Operators and Other Search Tools supported by CSA Illumina

Boolean operators help define the relationships between words or groups of words.

AND Use to narrow a search and retrieve records containing all of the words it separates

OR Use to broaden a search and retrieve records containing any of the words it separates

NOT Use to narrow a search and retrieve records that do not contain the term following it.

( ) Use to group words or phrases when combining Boolean phrases and to show the order in which relationships should be considered.

Proximity operators identify the number of words to come between the search terms.

WITHIN Use to narrow a search by specifying a proximity relationship of

"X"	fewer than "X" words between search terms.
NEAR	Use to narrow a search by specifying a proximity relationship of fewer than 10 words between search terms.

Special symbols can expand the scope of your search.

*	Truncate using the wild card symbol. This expands a search term to include forms of a root word (e.g. epox* retrieves epoxy, epoxies, etc.)
*	Find an unlimited number of characters within a word (e.g. col*r retrieves color, colour, etc.)
?	Find alternative spellings. The ? represents any single character; ?? represents two characters and so on. Use within or at the end of a word (e.g. gr?y finds grey as well as gray).

Note: Search queries containing several operators search in the following order:
( ), NEAR, NOT, AND, OR

Ready, Set, Search! Using the CSA Illumina Platform to Search CINDAS: Microelectronics Packaging Materials Database

Now that you have an understanding of what the *CINDAS: Microelectronics Packaging Materials Database* is about and how the searchable field codes and search tools function, you are ready to search the database using the CSA Illumina platform.

Clicking on 'Help & Support' at any time will direct you to a context-specific Help page.

QUICK, ADVANCED, OR COMMAND SEARCHING

On CSA Illumina, search strategies can be applied using one of three approaches.

- ***Quick Search*** restricts your search to anywhere (AY=). An anywhere search searches across all of the available fields in a record. Multiple words entered into the search field, will be treated as a phrase.
- ***Advanced Search*** gives you the advantage of being able to select any of the 5 field codes from a pull-down menu. The separate search boxes are formatted to include the Boolean Operators to help guide you in formatting your search.

- ***Command Search*** or *Professional Search* may be preferred by advanced users who are comfortable with entering search strategies without aid of a template.

SORTING FEATURES

The sorting features give you the opportunity to order your results based on the most relevant field code.

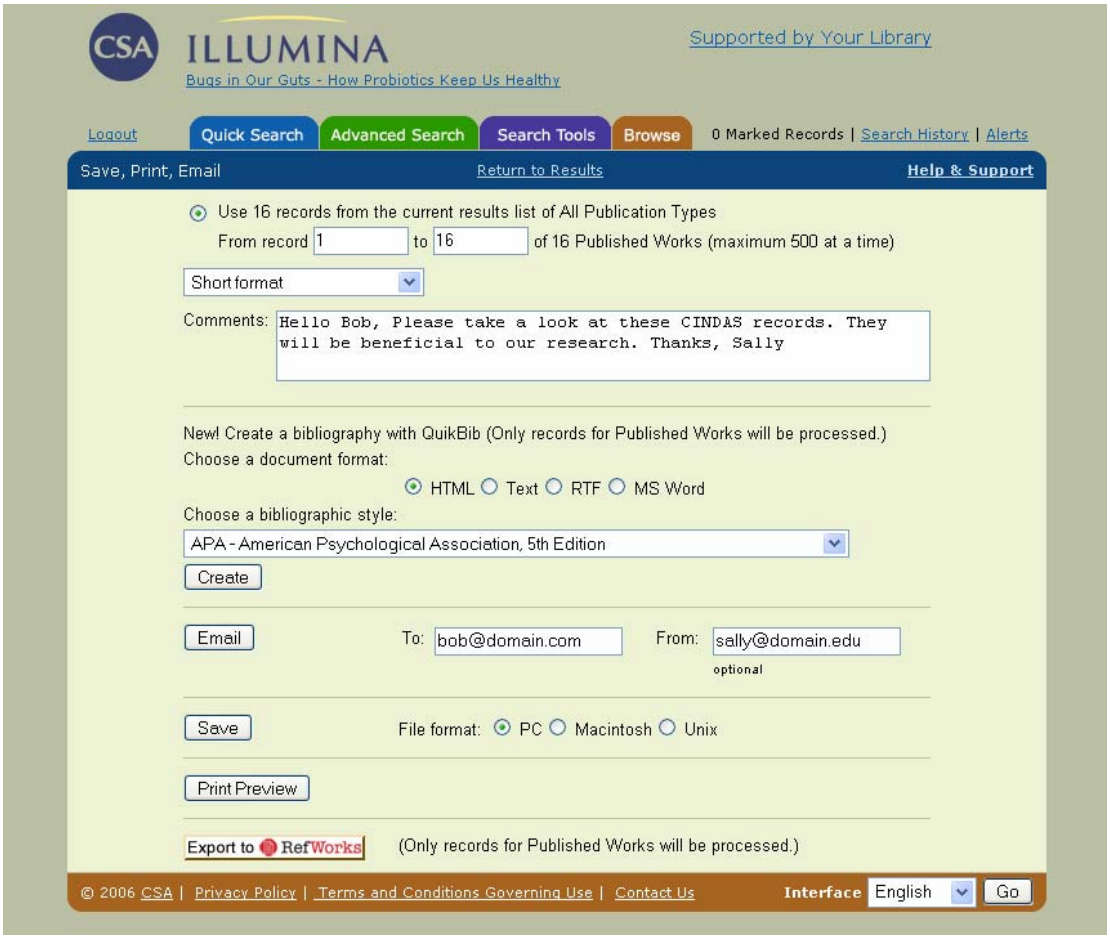
- ***Independent Variable***
- ***Material***
- ***Material Group***
- ***Property***
- ***Property Group***

RECORD VIEW

Select how many records to display from the 'Results per Page' pull-down menu: 10, 25 or 50.

PRINT, SAVE AND E-MAIL

Add records to your Marked Records list by clicking 'Mark' all on page, or check the boxes next to individual records and click 'Update Marked List.' Printing, saving, and e-mailing records can be done by using the 'Save, Print, E-mail' function.



Note: The 'QuikBib' and 'Export to RefWorks' features only function with Published Works, and are not available for records in the CINDAS databases.

The CINDAS: Microelectronics Packaging Materials Database Research Process

There are 2 primary ways to search the *CINDAS: Microelectronics Packaging Materials Database*. A database user can perform a search for key terms or phrases on the CSA Illumina platform, or browse the database directly on the CINDAS platform.

Search CINDAS: Microelectronics Packaging Materials Database on the CSA Illumina platform

I) Begin the Research Process

A. Determine your goals:

1. State your research question:
   “How can electronic equipment be protected in the extreme environment of an oil refinery?”
2. Set parameters for your search
   “What specific materials are relevant?”
   “What specific properties or test conditions are relevant?”

B. Identify general concepts:
1. What is the area of research?
   “Oil processing and automated control; Sensitive electronic (solid-state) components functioning under extreme conditions; Automated refining processes”
2. What is the premise for this research?
   “Toxicity and safety demands require robotic controls. How can these solid-state monitoring control devices be protected in extreme environments?”
3. Which general terms relate to your search?
   "encapsulants; silica; thermal expansion”

C. Choose the appropriate database
1. Is the *CINDAS: Microelectronics Packaging Materials Database* a relevant source of information for this research question?
   Yes, the data on thermal, mechanical, electrical and physical properties of electronics packaging materials in the *CINDAS: Microelectronics Packaging Materials Database* can be used to compare different silica epoxies and determine what the best material is to protect sensitive electronic components in extreme environments.

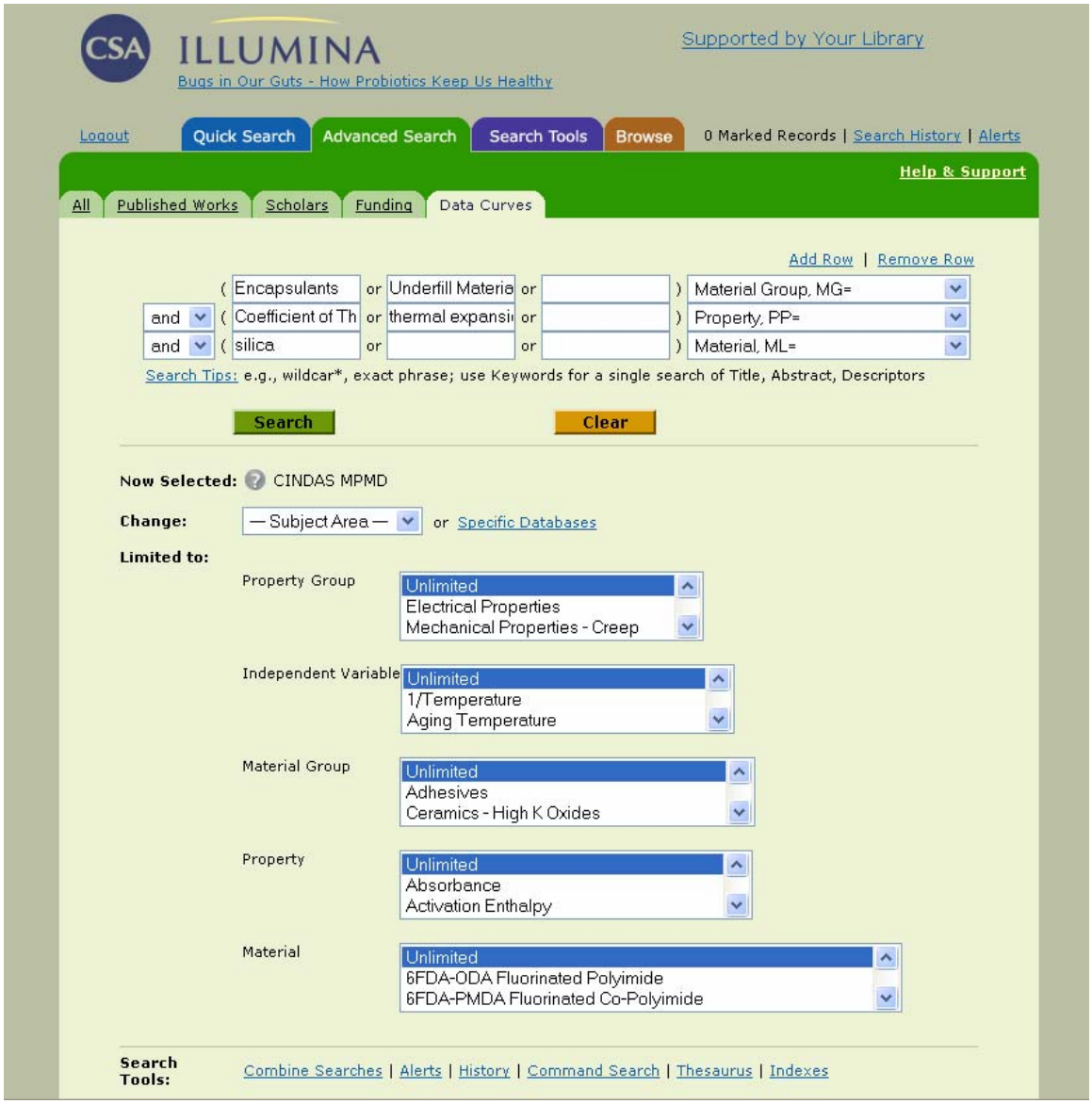
II) Build your Search Strategy

A. Quick Search:
1. Enter phrase or multiple search terms separated by Boolean operators AND to link terms, OR to link similar words or synonyms, in the Quick Search box:
   "encapsulants and thermal expansion”
2. Note: Consult the **Major Material Groups Covered** and **Properties Covered** sections of this *CINDAS: Microelectronics Packaging Materials Database* Guide or the Database Factsheet for relevant search terms.

B. Advanced Search:

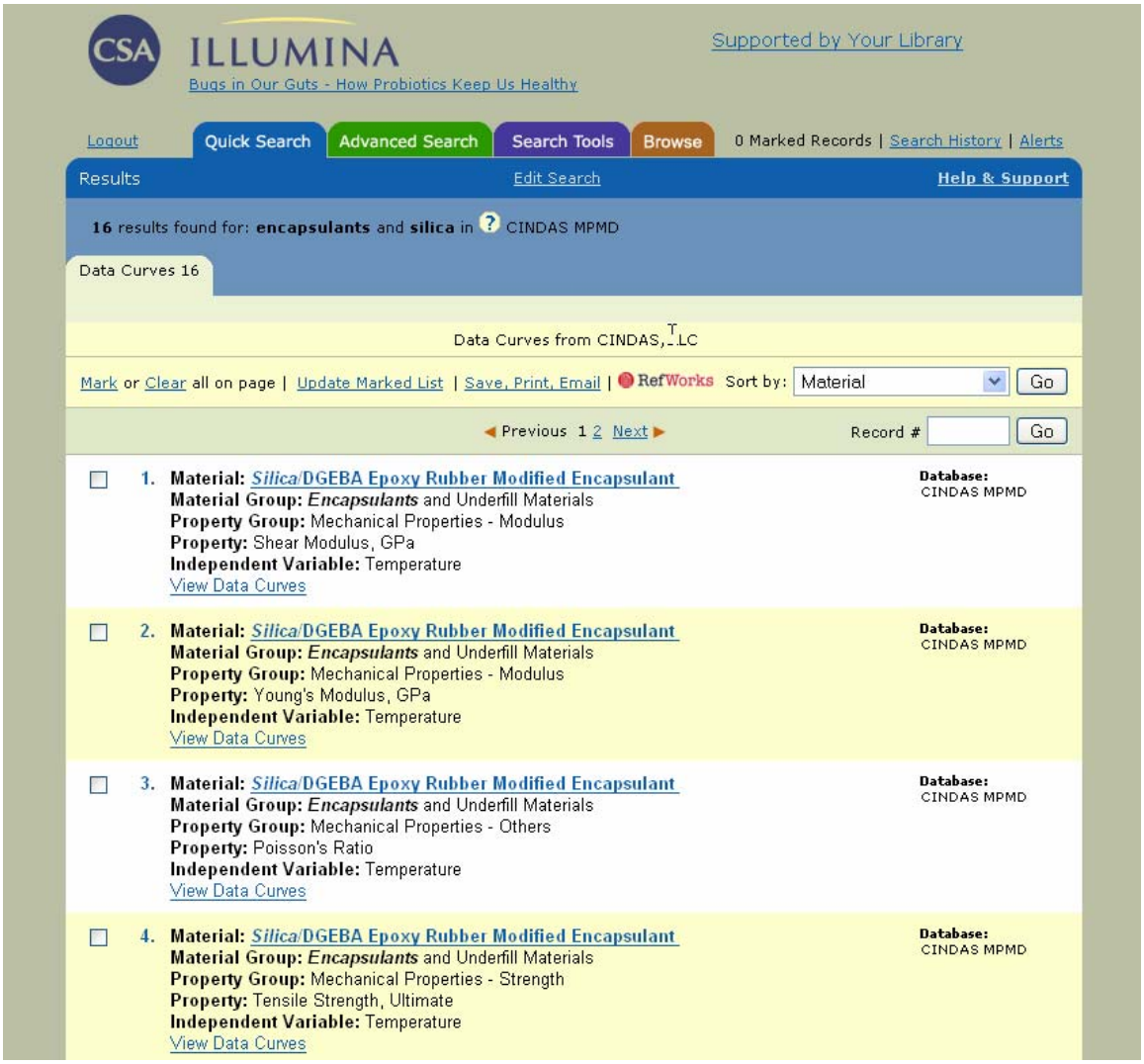
1. The Field Code drop-down boxes in the Advanced Search screen allow you to limit the search by any of the searchable field codes: Independent Variable (IA=), Material Group (MG=), Material (ML=), Property (PP=), and Property Group (PG=).
2. Enter phrase or multiple search terms separated by the Boolean operators AND to link terms, OR to link similar words or synonyms, provided in the Advanced Search screen:

   MG= (Encapsulants and Underfill Materials) and PP= (Coefficient of Thermal Linear Expansion or thermal expansion) and ML= silica
3. Note: Consult the **Major Material Groups Covered** and **Properties Covered** sections of this *CINDAS: Microelectronics Packaging Materials Database* Guide or the Database Factsheet for relevant search terms.



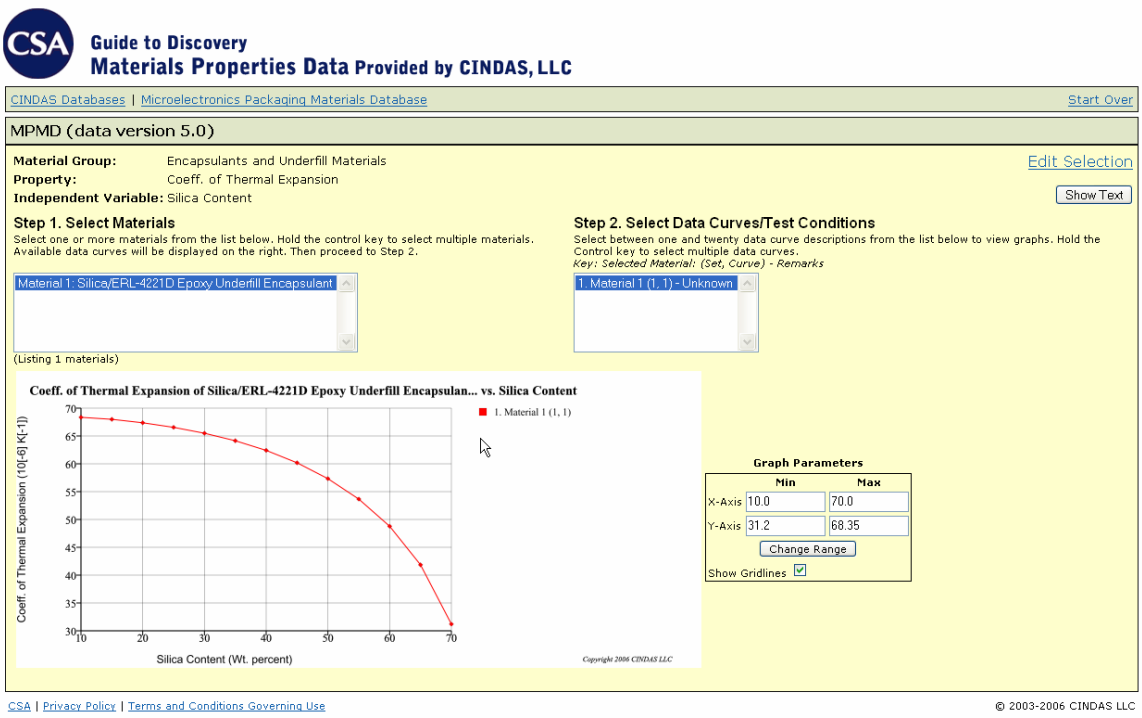
III) Analyze Results

A. Relevant results:
   1. Review the retrieved results and determine whether they are satisfactory:



2. If they are satisfactory, click on the "View Data Curves" link to view the appropriate data curve on the CINDAS platform:

   In this case, the results are relevant. One data curve in particular helps you identify a material that will show a decrease in thermal linear expansion if the amount of silica is modified. This material will envelop, shape, support, protect, connect solid-state electronic components (sensors, controllers, feedback devices).



B. If results are not relevant:
   1. Check spelling of search terms, and drop unnecessary or misleading terms.
   2. Increase precision: An excellent source for search terms is the ***Major Material Groups Covered*** and ***Properties Covered*** sections of this *CINDAS: Microelectronics Packaging Materials Database* Guide or the Database Factsheet. (To access the Database Factsheet, click on the "?" icon next to the database name, CINDAS MPMD, at the top of your results list.) Utilizing these materials groups and properties as search terms will increase the effectiveness of the search, and increase the number of relevant results retrieved.
   3. Finally, you may need to rethink whether the database you selected is appropriate for your search. (See IV **Search Multiple Databases Simultaneously** below.)

C. Too few/too many results:
   1. Increase retrieval by using fewer ANDs and more ORs
   2. Increase precision by using additional ANDs and fewer ORs (NOT can be used to exclude some terms)

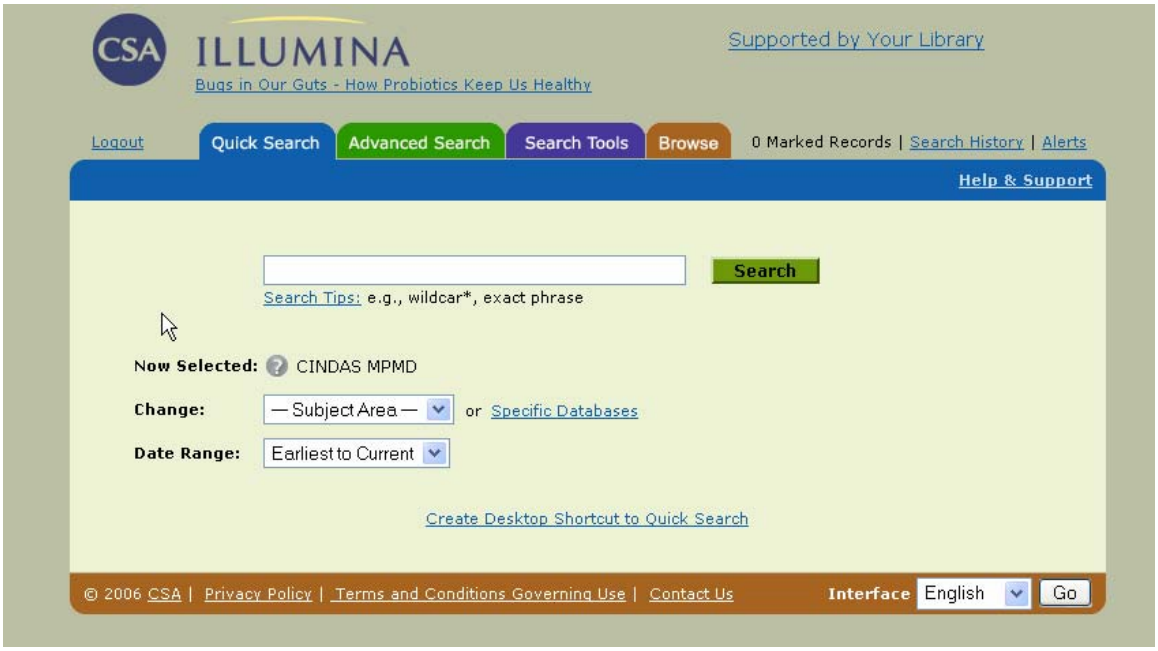
IV) Search Multiple Databases Simultaneously

You can also cross-search multiple CSA Illumina databases simultaneously to expand your search process and identify other sources of information. On CSA Illumina, the *CINDAS: Microelectronics Packaging Materials Database* (MPMD) can be searched as a stand alone file or, alternatively, it can be accessed via a search of CSA databases that contain related materials science records, such as the *CINDAS: Thermophysical*

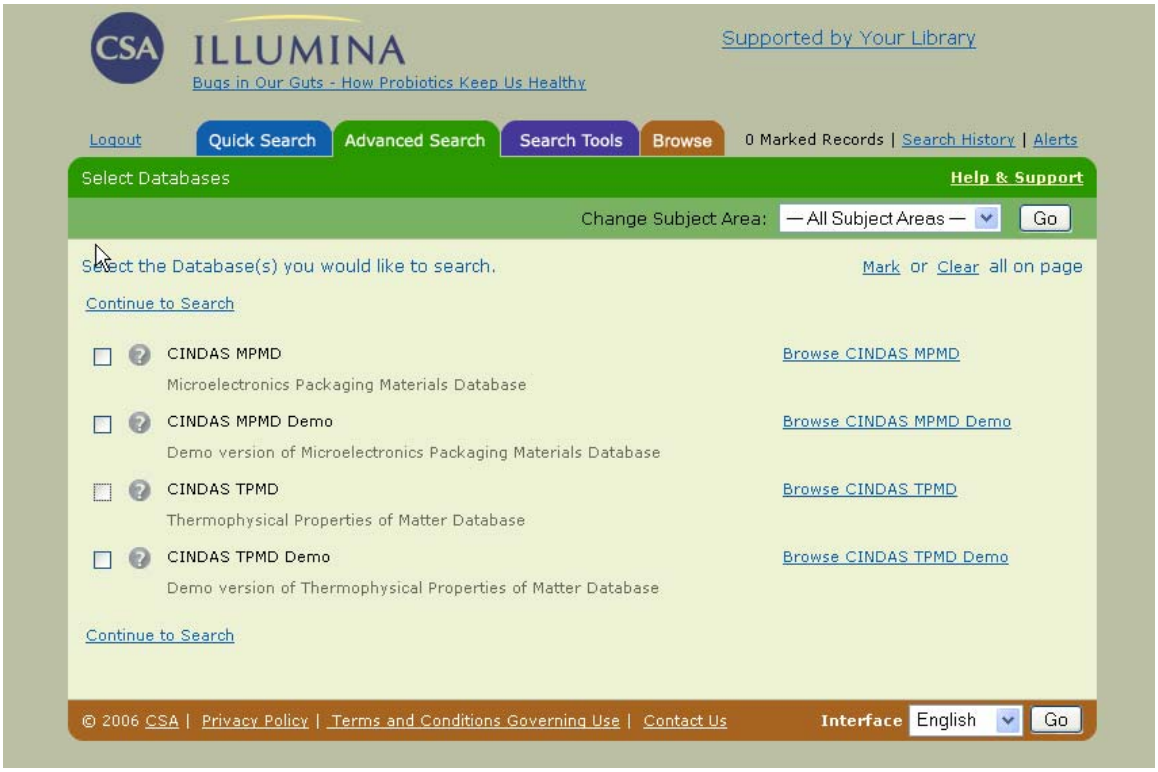
Properties of Matter Database (TPMD) and the *CSA Technology Research Database* (TRD).

Browse CINDAS: Microelectronics Packaging Materials Database on the CINDAS platform

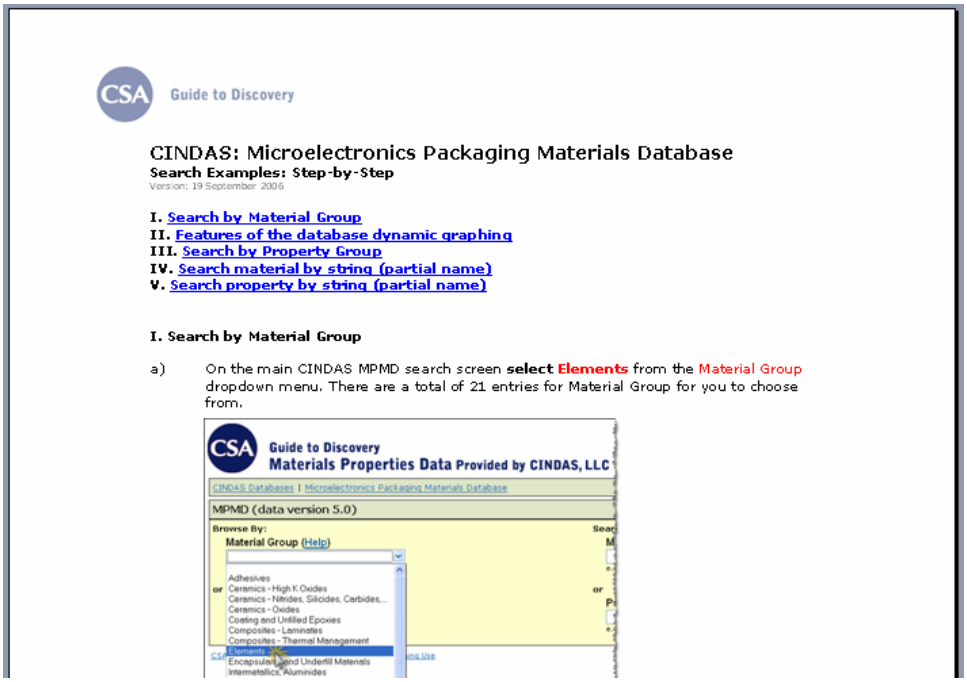
You can also browse the *CINDAS: Microelectronics Packaging Materials Database* directly on the CINDAS platform. From the Quick Search or Advanced Search screen on the CSA Illumina platform, click on the "Specific Databases" link.



Then click on the "Browse CINDAS MPMD" link to begin.



For more information on how to use the specific Browse and Search features on the CINDAS platform, refer to the **Search Examples: Step by Step Guide** for the *CINDAS: Microelectronics Packaging Materials Database* available in the Quick Links section of the Database Factsheet. To access the Database Factsheet, click on the "?" icon next to the database name, CINDAS MPMD, on the CSA Illumina platform.



Contact CSA:

For Technical Support: support@csa.com

For Training Requests: training@csa.com

For Training Materials: http://www.csa.com/support/trainingmaterial.php

For Sales Inquiries: sales@csa.com

For a complete list of CSA Illumina databases and other CSA products: http://www.csa.com/e_products/databases-collections.php