Brief introduction to materials science for the information professional

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• What is materials science?
• General trends in research
• Resources in materials science
EARLY MATERIALS SCIENCE

http://www.unisa.ac.za/default.asp?Cmd=ViewContent&ContentID=14960
MATERIALS SCIENCE IS...

• Relevant to our lives everyday
  – Travel
    • Airplanes
    • Cars
  – Communication
    • Cell phones
    • Laptops
  – Home
    • Silicone kitchen tools
    • Watches

• And our future
  – Energy!
MATERIALS SCIENCE IS...

• Highly interdisciplinary
  - Chemistry
  - Physics
  - Electrical and computer engineering
  - Mechanical engineering
  - Chemical engineering and materials science
  - Orthopedics
  - Aerospace engineering
  - Civil engineering
  - And more...
A LITTLE HISTORY

http://www.iom3.org/divisions/mpem/contents.htm
MAJOR CATEGORIES OF MATERIALS

1. http://www.scrap-metal-recovery.co.uk/customers.php
INCREASE IN STRENGTH TO DENSITY RATIO OF MATERIALS OVER TIME

MAJOR TRENDS

- Biomaterials & biocompatible materials
- Energy
- Self-assembled materials
- Nanomaterials
BIOMATERIALS & BIOCOMPATIBLE MATERIALS

• Drug delivery devices
• Replacement parts
  – Hearts
  – Joints
• Regeneration of tissues
  – Blood
  – Bone
  – Skin
ENERGY

• Recognition of problems with fossil fuels
  – Environmental effects
  – Dwindling supply and increasing costs

• Two aspects of particular interest
  – Fuel cells
  – Solar cells
FUEL CELLS

• Continuously fueled electrochemical devices
  – Fuel (hydrogen or hydrocarbons) in anode
  – Oxygen in cathode
• Output – electrical energy
• Important to “hydrogen economy”
SOLAR CELLS

- AKA photovoltaics
- More environmentally friendly
- First generation
  - Silicon wafers
- Second generation
  - Thin film technologies
- Third generation
  - Hot carriers
  - Multiple electron-hole pair creation
  - Thermophotonics
  - Organic-based photovoltaics
SELF-ASSEMBLED MATERIALS & NANOMATERIALS

• Self-assembled materials
  – Allows greater control of structure
  – Of interest for many different kinds of materials

• Nanomaterials
  – Broad appeal
  – Numerous applications make use
    • Biomaterials
      – Drug or iron delivery in bloodstream
    • Fuel cells
      – Increasing surface area of catalysts
    • Semiconductors
RESOURCES FOR MATERIALS SCIENCE

• General
  – Materials science
  – Other disciplines

• For specific types of materials
  – Ceramics
  – Metals
  – Nanomaterials
  – Polymers
  – Semiconductors
HANDBOOKS AND ENCYCLOPEDIAS

INTERNET SOURCES

MatWeb, Your Source for Materials Information

What is MatWeb?

The heart of MatWeb is a searchable database of material data sheets, including property information on thermoplastic and thermoset polymers such as ABS, nylon, polycarbonate, polyester, polyethylene and polypropylene, metals such as aluminum, cobalt, copper, lead, magnesium, nickel, steel, superalloys, titanium and zinc alloys; ceramics; plus semiconductors, fibers, and other engineering materials.

MatWeb is freely available and does not require registration. However, comparison tools and other advanced features, are only available to our freely Registered and paid Premium users. Premium users also can export data into CAD-FEA programs, including:

- COMSOL MULTIPHYSICS
- SolidWorks
- ALGOR
- PLS-TOOL
- NEiWorks
- ANSYS

How to Find Property Data in MatWeb

Quantitative Searches:

- Physical Properties - Metric
- Physical Properties - Common US

Categorized Searches:

- Material Type
- Polymer Manufacturer

Text Search:

- Enter a key word or phrase in the box below (this search is also available at the top of every page)

www.matweb.com
SEARCH OPTIONS IN MATWEB

Search MatWeb for Property Information

Search MatWeb using our most powerful search, the Advanced Search, or try one of the following search options:

- **Advanced Search**: MatWeb's most powerful search tool allows users to build complex searches in an iterative process. Possible criteria are property, composition, material category, and user-input text options. (Registration Required).

- **Quick Search**: Accepts user-input text and will prioritize and split multiple terms differently than the Advanced Search. Located in the upper right of every MatWeb page and is reproduced here:

  [SEARCH]

- **Material Property Search**: Find materials that meet the property value ranges that you require. Available with Metric or Common US Units.

- **Metal Composition Search**: Enter an elemental composition and find the matching alloys.

- **Material Type/Category Search**: Select the type of material in which you are interested from a systematic list of drop-down boxes.

- **Polymer Manufacturer Search**: Select a plastics manufacturer and find data sheets of their proprietary products listed in MatWeb.

- **Polymer Trade Name Search**: Select a plastics trade name and find data sheets listed in MatWeb.

- **Polymer Film Search**: Find film grade polymers that meet the property value ranges that you require. Available with Metric or Common US Units.

- **Lubricant Search**: Find lubricants that meet the property value ranges that you require. Available with Metric or Common US Units.

- **Metal Alloy UNS Number**: Select from the list of UNS numbers in MatWeb's database and find the matching data sheets.

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*Subscribe to Premium Services*
Materials Properties

The NIST Materials Data Program provides evaluated data on phase equilibria, structure and characterization, and performance properties.

Several materials performance property databases are now available, including the online NIST Ceramics WebBook which provides numeric data for physical and structural characteristics, mechanical and thermal properties, and properties of advanced ceramic materials.

The codes in the list below have the following meanings:

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC</td>
<td>PC product, most available for purchase, some are free</td>
</tr>
<tr>
<td>Online</td>
<td>Free online system</td>
</tr>
<tr>
<td>DG</td>
<td>Inclusion in the NIST Data Gateway - a portal providing access to many NIST scientific and technical databases. It is searchable by keyword, property, or substance name.</td>
</tr>
<tr>
<td>*</td>
<td>Product contains data that have undergone rigorous critical evaluation by experienced researchers who recommend best values.</td>
</tr>
</tbody>
</table>

- NIST FAST
- Data Test Database, PC, DG*
- NIST Database on Reinforcement Permeability Values, Online, DG*
- Phase Equilibria Diagrams Database, PC, DG*
CENTER FOR INFORMATION & NUMERICAL DATA ANALYSIS & SYNTHESIS (CINDAS)

- Purdue University
- Microelectronics Packaging Materials Database
- Thermophysical Properties of Matter Database
- Licensed through CSA (Cambridge Scientific Abstracts)
DATABASES

• CSA Materials Research Database with METADEX
  – Aluminium Industry Abstracts
  – Ceramic Abstracts/World Ceramics Abstracts
  – Copper Data Center Database
  – Corrosion Abstracts
  – Engineered Materials Abstracts
  – Materials Business File
  – METADEX
  – WELDASEARCH

• Can search separately
OLD FAVORITES

SAMPLE SEARCH IN KNOVEL

Search for:
- nanoparticles and materials
  - Query Examples: "polymers in oxide" AND chemical resist

Search in:
- All Text
- All Subject Areas
- Entire Knovel Library
- My Subscription

Search Query (nanoparticles and materials)
No. of Titles Retrieved: 59
Nanoparticles and materials

Search in:
- All Text
- All Subject Areas
- Entire Knovel Library
- My Subscription
- This Title Only

Search Query: (nanoparticles and materials)
Search Results in this Title: 61 Text Hit(s)
No. of Titles Retrieved: 59

Sections Retrieved
- 3.4.1 Melting Points and Lattice Constants
- Index
- 3.2.4 Synthesis of Semiconductor Nanoparticles
- 1.2 Emergence of Nanotechnology
- 1.5 Scope of the Book
- 2.3 Chemical Potential as a Function of Surface Curvature
- 3.1 Introduction

Relevance: 100%
Data (Records): Text (4)
Text (Pages): Text (4)
SEARCH TIPS

- Use truncation (*) to search for words that begin with the same letters. For example, "comput*" returns computer, computers, computation.
- Truncation can also be used to replace any number of characters internally. For example, "sulfate" returns sulphate or sulfate.
- Use wildcard (?) to replace a single character. For example, "women?" retrieves woman or women.
- Terms are automatically stemmed, except in the author field, unless the "Auto-stemming off" feature is checked.
ELECTRICAL ENGINEERING LITERATURE

- Literature relevant to applications of interest
- Semiconductors – EE literature
- IEEE Xplore
  - Journals and magazines
  - Conference proceedings
  - Standards
  - Books
RESOURCES FOR SPECIFIC MATERIALS

- Ceramics
- Metals
- Nanomaterials
- Polymers
Contributions to the Ceramics WebBook are greatly encouraged. If you know of a suitable database, tool, or resource, please send the pertinent citation or URL, along with a brief description. The Ceramics WebBook contains references and links to other web sites because they may have information that would be of interest to you. No intention should be drawn on account of other sites being referenced, or not, from this page.

There may be other web sites that are more appropriate for your purpose. NIST does not necessarily endorse the views expressed, or content, with the facts presented on these sites. Further, NIST does not endorse any commercial products that may be mentioned on these sites.

**Selections**

<table>
<thead>
<tr>
<th>Evaluations Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Includes the NIST Superconducting Materials Database, the NIST Structural Ceramics Database, and a collection of Property Data Summaries.</td>
</tr>
</tbody>
</table>

**Guide to Data Centers and Sources**

<table>
<thead>
<tr>
<th>Issues and descriptions for material data center and sources of information.</th>
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**Tool and Resources**

| Includes links to software and other resources useful for materials research. |

**Recent Updates**

A new data evaluation tool has been added to the Division's suite of tools and resources.

Data evaluation tools provide a means of identifying property data according to how the data were acquired, processed, and reported. This tool is based on the operational protocol discussed in the NIST Recommended Practice (Guide SP 100-11). The protocol provides an interactive, step-by-step procedure in the manner of a decision tree. Based on the user's responses to a series of questions, the tool determines the appropriate data evaluation level for a given set of data.
METALS: PROPERTY DATA

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NANOMATERIALS
POLYMERS: ENCYCLOPEDIAS

Welcome to a wealth of data online with the new CRC Polymers: A Property Database.
This new version enables quick and easy access to everything the Property Database has to offer. Whether you want to browse through the Table of Contents or search for a specific piece of data, you'll be sure to find what you were looking for, and more quickly than ever before.
Any questions?