MATERION

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TECHNICAL TIDBITS

MATERION PERFORMANCE ALLOYS

MATERIAL PROPERTIES & SYSTEM PROPERTIES

In university textbook examples and on exams, the answer to a number of problems depends upon factors that are not readily known.

We're not talking about real estate –
A brief discussion of the different classifications of material properties

The next issue of Technical Tidbits will discuss property ranges and statistics.

The problem statement may include a phrase like "Assume a coefficient of friction of 0.30". The reason that it must be assumed is that in the real world, friction is highly dependent on a number of other variables in the system, and is not associated with any given material in the system. This is what distinguishes material properties from system properties.

Material Properties are known and measurable for any given material under given conditions. Unless otherwise specified, they are measured at room temperature, atmospheric pressure and under a standard gravitational acceleration of 1 g. Electrical properties are typically specified under DC or low frequency AC currents, or are presented as a function of frequency.

Material properties may be functions of

- Temperature (Strength, Conductivity, Specific Heat, Toughness)
- Strain Rate (Strength, Toughness)
- Electric Field Strength (Permittivity)
- Magnetic Field Strength (Permeability)
- Pressure (Melting/Freezing Temperature)
- Frequency (Dielectric Constant)
- Time (Stress Relaxation)

Physical properties are those that are theoretically intrinsic to the material and do not change (or change very little) with how the material is processed. Examples of physical properties are:

- Density
- Elastic Modulus
- Poisson's Ratio
- Modulus of Rigidity
- Speed of Sound

Mechanical properties are those that are readily changed by processing. These properties vary greatly with and are tailored by how the material is hot worked, cold worked and heat treated. Examples include:

- Yield Strength, Elastic Limit, Proportional Limit, etc.
- Tensile Strength
- Hardness
- Tensile Elongation
- Toughness

Electrical and magnetic properties are influenced by what is happening on an atomic level with electrons and charge. Most magnetic properties are measured under at a specific applied magnetic field strength. Examples include:

- Electrical Conductivity/Resistivity
- Permittivity (Dielectric Constant)
- Magnetic Permeability, Remanence, Coercivity, Saturation, etc.
- Curie Temperature

Thermal properties include:

- Melting/Freezing and Boiling Temperatures
- Thermal Conductivity/Diffusivity
- Thermal Expansion Coefficient
- Specific Heat

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MATERIAL PROPERTIES AND SYSTEM PROPERTIES (CONTINUED)

System properties result from multiple materials being used together and change based upon multiple conditions. They arise from the combination of material properties, loads, surface conditions, and environmental conditions. Examples of system properties include:

- Coefficient of Friction
- Wear Rate
- Electrical Contact Resistance
- Electrical Circuit Properties (Resistance, Capacitance, Inductance, Impedance, Jitter)

System properties may be functions of:

- Contact Force (Friction, Contact Resistance, Wear Rate)
- Surface Roughness (Friction)
- Velocity (Friction, Wear Rate)
- Surface Coatings and Contamination (Contact Resistance, Friction)
- Environmental Conditions (Contact Resistance, Friction)
- Time (Contact Resistance, Wear Rate)
- Distance (Capacitance)
- Length (Resistance, Inductance)
- Surface Area (Capacitance)
- Hardness (Wear, Friction, Contact Resistance)
- Temperature (Contact Resistance)
- Frequency (Impedance)
- Geometry (Loop Inductance, Maximum Current Rating)

Imagine two rough materials of known hardness in contact with each other. When surface slides across the other under a constant normal force, there will be a certain coefficient of friction generated. If the two surfaces are subsequently polished and the test is rerun, the friction coefficient will be lower, despite the fact that the hardness (and all other material properties) of the two surfaces have not changed. If you replace one of the materials with another, the friction coefficient would change. If you apply different lubricants to the surface, the frictional behavior would change. If you change the shape of the surfaces in contact, the friction would change. This is why it is so difficult to determine what the proper coefficient of friction would be in your particular design.

Material properties are easy to find on data sheets, on websites, in handbooks, etc. System properties are another story. For example, you may be able to find tables of frictional coefficients in published literature, but such numbers are only valid for the specific conditions under which they were tested. Often, you will even find a range of numbers, as the coefficient of friction may change throughout the test. The best you can hope to do is find a system that closely resembles yours and use a similar range in your calculations, while carefully documenting the assumptions that you make along the way.

Written by Mike Gedeon of Materion Performance Alloys Marketing Department. Mr. Gedeon's primary focus is on electronic strip for the automotive, telecom, and computer markets with emphasis on application development.

References:

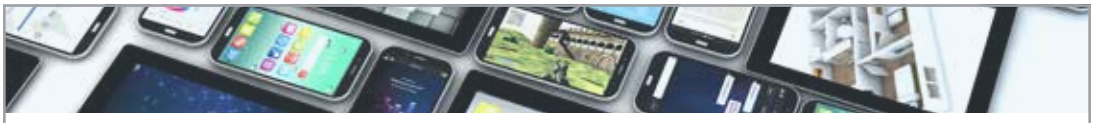
Technical Tidbits Issue No. 6 "The Importance of Contact Force."

Technical Tidbits Issue No. 73 "Introduction to Friction."

Please contact your local sales representative for further information on material hardness or other questions pertaining to Materion or our products.

Health and Safety

Handling copper beryllium in solid form poses no special health risk. Like many industrial materials, beryllium-containing materials may pose a health risk if recommended safe handling practices are not followed. Inhalation of airborne beryllium may cause a serious lung disorder in susceptible individuals. The Occupational Safety and Health Administration (OSHA) has set mandatory limits on occupational respiratory exposures. Read and follow the guidance in the Material Safety Data Sheet (MSDS) before working with this material. For additional information on safe handling practices or technical data on copper beryllium, contact Materion Performance Alloys or your local representative.



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