

Variable Material Properties

This article defines which supported material properties can vary with which model parameters. For an explanation of supported material types, see the article *Materials*. Most Fluid/Thermal type material properties can be defined to vary with time or temperature. Some can vary with other model parameters..

An alternative method for defining temperature dependent material properties for TMG is to use Interpolation Relationships. See *Defining an Interpolation Relationship*.

Variable *Thermal Solid* Type Material Properties

Temperature or Time

The following *Thermal Solid* material properties can be defined as variable versus time or temperature.

- Thermal Conductivity. **Note:** uniquely, Thermal Conductivity can also be defined as bivariate (temperature *and* time).
- Emissivity
- Reverse Side Emissivity
- Electrical Resistivity
- Specific Heat (Simulation material types *Isotropic* or *Orthotropic*). When defined, this value takes precedence over *Specific Heat Below Phase Change Temperature* and *Specific Heat Above Phase Change Temperature*. **This property does not support phase change.**
- Specific Heat Below Phase Change Temperature

Note: There are two *Thermal Solid* type material properties you can use to define specific heat for an analysis with phase change, *Specific Heat Below Phase Change Temperature* (constant or variable) and *Specific Heat Above Phase Change Temperature* (constant only). If the specific heat is one constant value below phase change, and another constant value above, define both properties with appropriate constant values.

If the specific heat varies with temperature above and/or below the phase change, define the

temperature dependency using *Specific Heat Below Phase Change Temperature* only. The temperature range of the table must cover temperatures above and below the phase change temperature. These values will take precedence over any value for *Specific Heat Above Phase Change Temperature*.

For a material which does not change phase (that is, a material which does not have a Phase Change Temperature and Latent Heat defined), the *Specific Heat Below the Phase Change Temperature* is used.

Temperature Dependent Absorptivity

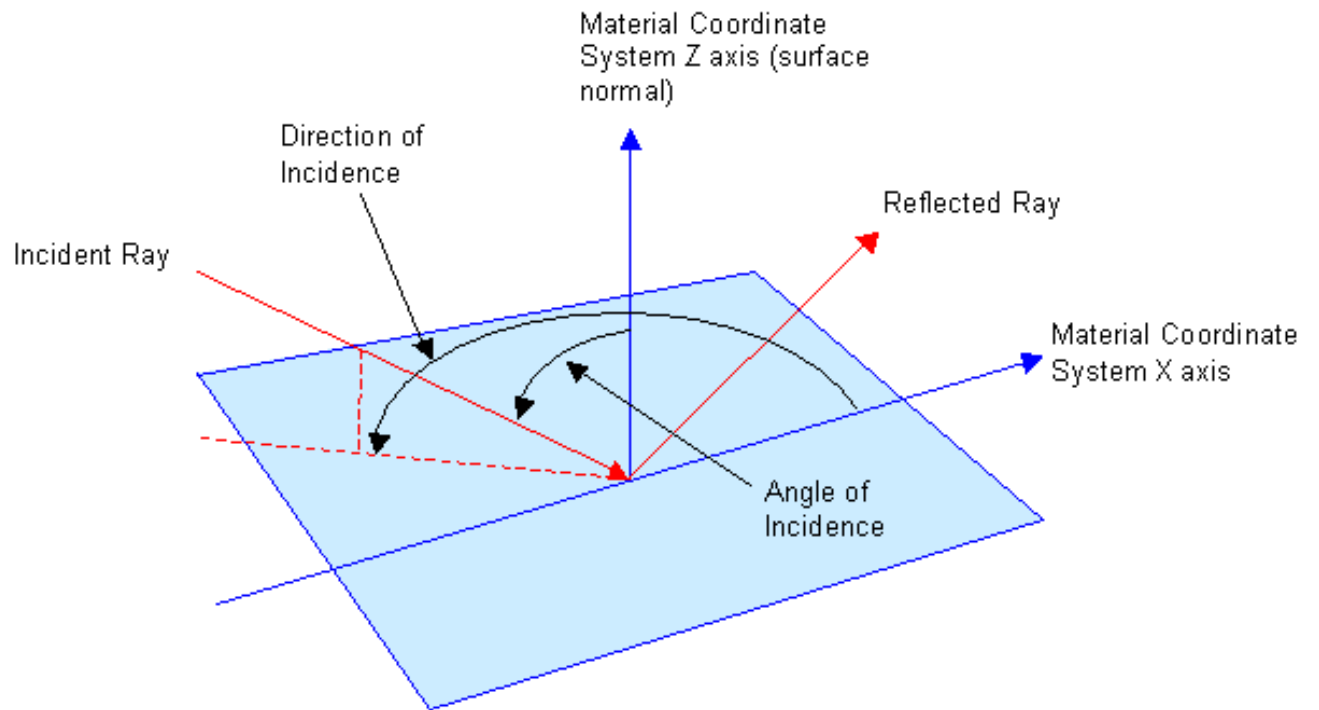
Absorptivity can be defined as varying with temperature.

Angle of Incidence and Direction of Incidence

The following *Thermal Solid* material properties can be defined as variable versus angle of incidence and direction of incidence.

- Solar Specular Reflectivity
- Reverse Side Solar Specular Reflectivity
- IR Specular Reflectivity
- Reverse Side IR Specular Reflectivity
- Solar Transmissivity
- IR Transmissivity

The Angle of Incidence and the Direction of Incidence are defined in the following figure:



Variable Properties for Isotropic and Orthotropic Material Types

When the material types *Simulation (Isotropic)* and *Simulation (Orthotropic)* are used for TMG, they support the same variable material properties as the *Fluid/Thermal (Thermal Solid)* type. For variable Isotropic Thermal Conductivity you can define different variability for the X, Y and Z directions.

Variable *Liquid* and *Gas* Material Properties

You can define the following *Liquid* and *Gas* material properties to vary with temperature or time or pressure.

- Mass Density (Liquid only)
- Thermal Conductivity
- Viscosity (Dynamic)
- Specific Heat at Constant Pressure

- Specific Heat at Constant Volume

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