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# **ultrafast Documentation**

***Release 1***

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## ultrafast.core module

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This module contains the core functionality required for performing ultrafast optics calculations. It currently focusses on providing classes for describing materials commonly employed in ultrafast optics.

**class** `ultrafast.core.Material` (*n*, *range\_*, *name=None*, *references=None*, *comments=None*)

Bases: `object`

### Parameters

- **n** (*callable*) – Dispersion function
- **range** (*tuple*) – Valid range for dispersion function (low,high)
- **name** (*string*) – Material name
- **references** (*string*) – Reference(s) for material properties
- **comments** (*string*) – Comments

Base class describing a (dispersive) material utilized in ultrafast optics.

The dispersion function *n* is a callable which takes one argument, the angular frequency in *rad/fs*, and returns the refractive index at this angular frequency.

The frequency range *range\_* is a tuple of length 2 describing the lower and upper angular frequencies for which *n* is valid.

### **name = None**

Name of the material. This can be used for reference, e.g. in case the instance name is not related to the material

### **references = None**

Reference(s) for material properties, e.g. journal articles

### **comments = None**

Comments string

### **range\_**

Range of angular frequencies (*rad/fs*) over which dispersion function *n* is valid. A numeric tuple of the form (low,high).

### **n**

A callable which takes one argument, the angular frequency in *rad/fs*, and returns the refractive index at this angular frequency.

### **wavevector** (*omega*)

**Parameters** **omega** (*float*) – Angular frequency in *rad/fs*

Returns the effective wavevector ( $\omega n/c$ ) at the angular frequency *omega*

**brewster** (*omega*, *inc\_mat*=None)

**Parameters**

- **omega** (*float*) – Angular frequency in *rad/fs*
- **inc\_mat** (*ultrafast.core.Material*) – Incident material

Returns the Brewster angle for light rays incident from the material *inc\_mat*. If None, *inc\_mat* is assumed to be *air*.

**class** *ultrafast.core.RIIDMaterial* (*db*)

Bases: *ultrafast.core.Material*

**Parameters** **db** (*string*) – Database entry

Class describing a dispersive material catalogued in the [RefractiveIndex.info](#) database.

An instance is built from the RefractiveIndex.info database entry *db*. Entries are stored as YAML files. As such, *db* may be a path to a local YAML file, or a URL to a remote YAML file accessible via HTTP.

**type\_** = None

String describing the dispersion data type as defined in the RefractiveIndex.info database, e.g.: formula 1, tabulated k, etc

**exception** *ultrafast.core.UltrafastError*

Bases: *Exception*

Ultrafast module base exception class

**exception** *ultrafast.core.RangeError* (*value*, *valid*, *message*)

Bases: *ultrafast.core.UltrafastError*

**Parameters**

- **value** (*float*, *int*) – Invalid value
- **valid** (*tuple*) – Valid range
- **message** (*string*) – Error message

Raised when the numeric value *value* is found to be out of the valid range defined by *valid*. *valid* is a tuple of length 2 in the form of (low,high).

**exception** *ultrafast.core.PropertySetError* (*property\_*, *message*)

Bases: *ultrafast.core.UltrafastError*

**Parameters**

- **property** (*string*) – Property attribute
- **message** (*string*) – Error message

Raised when attempting to set the property attribute *property\_* to an invalid value.

*ultrafast.core.frequency* (*lambda\_*)

**Parameters** **lambda** (*float*) – Wavelength in  $\mu m$

Wavelength to angular frequency conversion.

Returns the corresponding angular frequency in *rad/fs*

*ultrafast.core.wavelength* (*omega*)

**Parameters** **omega** (*float*) – Angular frequency in *rad/fs*

Angular frequency to wavelength conversion.

Returns the corresponding wavelength in  $\mu m$

`ultrafast.core.c = 0.29979245800000004`

Speed of light in  $\mu m/fs$ . Defined for convenience

`ultrafast.core.air = <ultrafast.core.RIIDMaterial object>`

`ultrafast.core.RIIDMaterial` describing air (Ciddor 1996). Defined for convenience



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### Overview

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ultrafast is a Python package designed to facilitate numerical calculations for ultrafast optics.



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### Features

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- Dispersive material class including parametric dispersion relations
- Interface to [RefractiveIndex.info](https://refractiveindex.info) database for quick and simple access to a wide range of materials



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## Requirements

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- Python (tested with 3.4)
- PyYAML (tested with 3.11)
- SciPy (tested with 0.17.1)



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### License

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