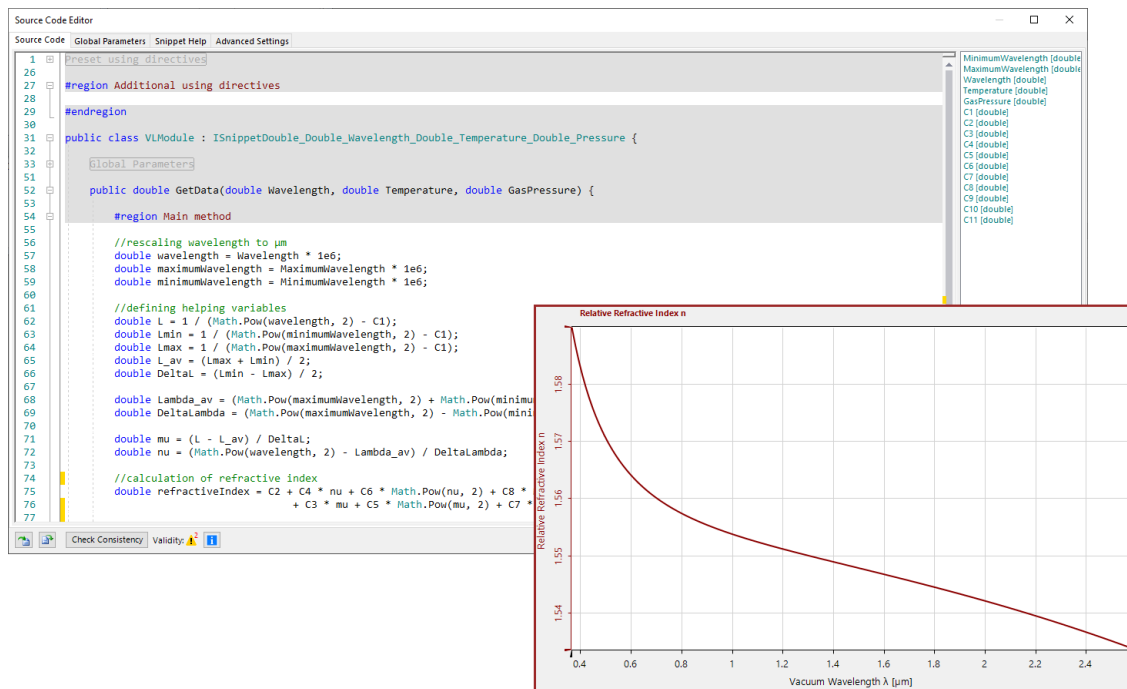


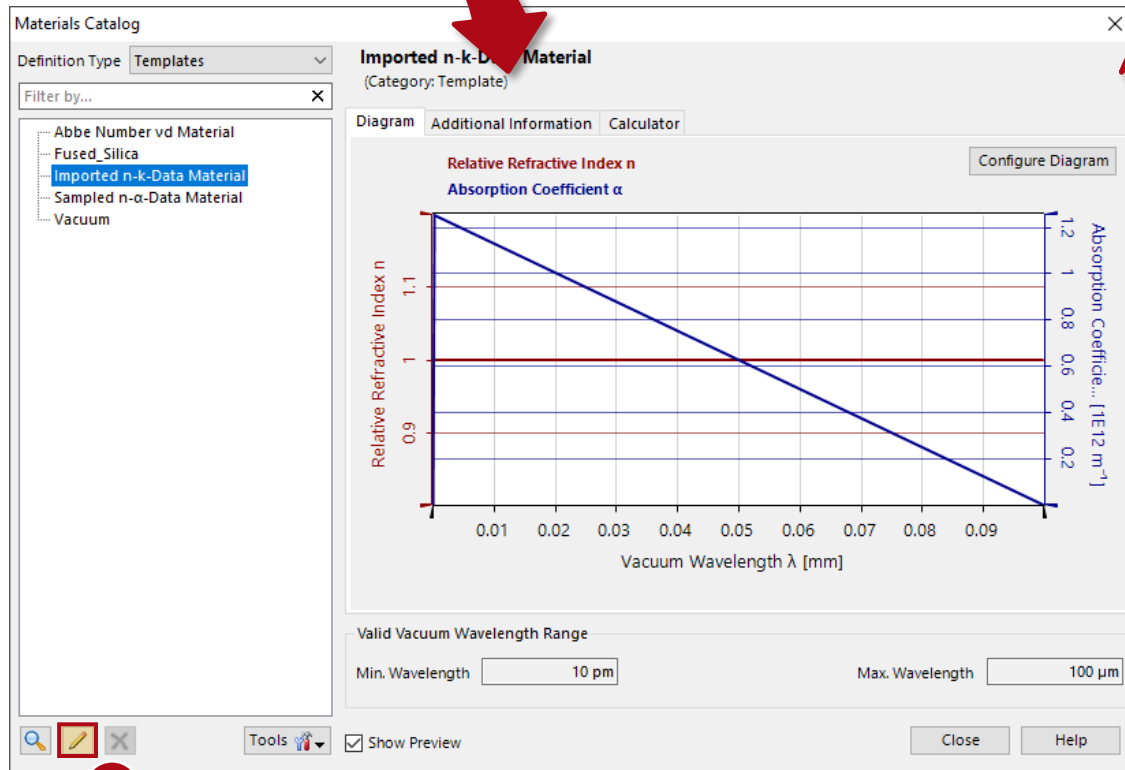
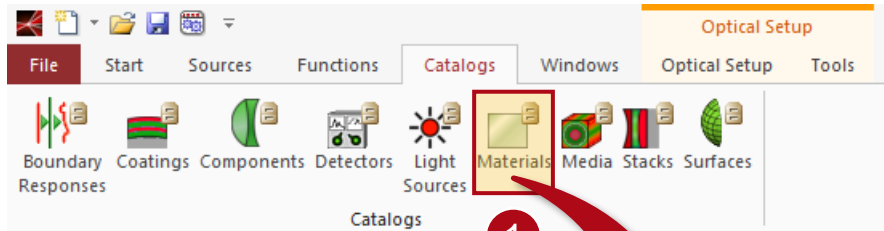
Programmable Dispersion Function

Abstract



The accurate definition of the optical parameters of materials, such as the refractive index, is a necessity for the modeling of any optical system. One handy option to specify the wavelength-dependent index of refraction are so-called dispersion formulas, which typically provide the data over a large spectral range just by defining a manageable number of coefficients. VirtualLab Fusion is shipped with a wide selection of commonly used dispersion formulars (e.g. Sellmeier, Cauchy), but also allows for an easy programming of additional types. In this document, the programming of a dispersion formula is shown at the example of the glass GOST BK9 by applying the Reznik definition.

Definition of Materials by Dispersion Formulas $n(\lambda)$



Edit Material Data

Material Name Imported n-k-Data Material

Refractive Index Absorption Coefficient Additional Information Temperature Data

Define Refractive Index by

Dispersion Formulas

Programmable

Sellmeier 1

Sellmeier 2

Sellmeier 3

Sellmeier 4

Sellmeier 5

Schott

Herzberger

Conrady

Handbook Optics 1

Handbook Optics 2

Cauchy

Edlén 1994 (for Air)

Edlén 1953 (for Air)

Programmable

Power Series

Abbe Number (v_d)

Abbe Number (v_e)

$n = \text{calc}(\lambda)$

Validity:

UnitScaleFactorWavelength 1 nm

Domain of Definition

Vacuum Wavelength Range 10 μm to 100 μm

Usable Vacuum Wavelength Range 10 μm to 100 μm

Tools Validity: Ok Cancel Help

Note: Please keep in mind, that in this case the refractive index and the absorption coefficient both can and need to be defined by their own Snippet.

Example: Reznik Dispersion Formula $n(\lambda)$

Definition of Reznik formula:

$$n(\lambda) = c_2 + c_4v + c_6v^2 + c_8v^3 + c_{10}v^4 + c_3\mu + c_5\mu^2 + c_7\mu^3 + c_9\mu^4 + c_{11}\mu^5$$

with:

$$v = \frac{\lambda^2 - \lambda_{av}}{\Delta\lambda} \text{ and } \mu = \frac{L - L_{av}}{\Delta L}$$

and:

$$L = \frac{1}{\lambda^2 - c_1}, L_{\min} = \frac{1}{\lambda_{\min}^2 - c_1}, L_{\max} = \frac{1}{\lambda_{\max}^2 - c_1}, L_{av} = \frac{L_{\max} + L_{\min}}{2}, \Delta L = \frac{L_{\min} - L_{\max}}{2}$$

and:

$$\lambda_{av} = \frac{\lambda_{\max} + \lambda_{\min}}{2}, \Delta\lambda = \frac{\lambda_{\max} - \lambda_{\min}}{2}$$

Example: Reznik Dispersion Formula $n(\lambda)$

Material Name: Imported n-k-Data Material

Refractive Index | Absorption Coefficient | Additional Information | Temperature Data

Define Refractive Index by

Dispersion Formulas

Programmable

$n = \text{calc}(\lambda)$

Sampled Dispersion

Constant

Data

Relative to Reference Material

Definition

Edit

Validity: ✓

Parameters

DispersionData

UnitScaleFactorWavelength: 1 nm

Domain of Definition

Vacuum Wavelength Range: 10 pm to 100 μm

Usable Vacuum Wavelength Range: 10 pm to 100 μm

Validity: ✓

Ok Cancel Help

```
1  Preset using directives
26
27  #region Additional using directives
28
29  #endregion
30
31  public class VModule : ISnippetDouble_Double_Wavelength_Double_Temperature_Double_Pressure {
32
33      Global Parameters
34
35      public double GetData(double Wavelength, double Temperature, double GasPressure) {
36
37          #region Main method
38
39              //rescaling wavelength to μm
40              double wavelength = Wavelength * 1e6;
41              double maximumWavelength = MaximumWavelength * 1e6;
42              double minimumWavelength = MinimumWavelength * 1e6;
43
44              //defining helping variables
45              double L = 1 / (Math.Pow(wavelength, 2) - C1);
46              double Lmin = 1 / (Math.Pow(minimumWavelength, 2) - C1);
47              double Lmax = 1 / (Math.Pow(maximumWavelength, 2) - C1);
48              double L_av = (Lmax + Lmin) / 2;
49              double DeltaL = (Lmin - Lmax) / 2;
50
51              double Lambda_av = (Math.Pow(maximumWavelength, 2) + Math.Pow(minimumWavelength, 2)) / 2;
52              double DeltaLambda = (Math.Pow(maximumWavelength, 2) - Math.Pow(minimumWavelength, 2)) / 2;
53
54              double mu = (L - L_av) / DeltaL;
55              double nu = (Math.Pow(wavelength, 2) - Lambda_av) / DeltaLambda;
56
57              //calculation of refractive index
58              double refractiveIndex = C2 + C4 * nu + C6 * Math.Pow(nu, 2) + C8 * Math.Pow(nu, 3) + C10 * Math.Pow(nu, 4)
59              + C3 * mu + C5 * Math.Pow(mu, 2) + C7 * Math.Pow(mu, 3) + C9 * Math.Pow(mu, 4) + C11 * Math.Pow(mu, 5);
60
61          }
62
63      }
64
65  }
```

MinimumWavelength [double]
MaximumWavelength [double]
Wavelength [double]
Temperature [double]
GasPressure [double]
C1 [double]
C2 [double]
C3 [double]
C4 [double]
C5 [double]
C6 [double]
C7 [double]
C8 [double]
C9 [double]
C10 [double]
C11 [double]

Check Consistency Validity: ⚠️

Ok Cancel Help

In the *Source Code Editor* local and global variables can be defined (e.g. for the coefficients) and it enables the definition of the desired dispersion formula.

GOST BK9 with Reznik Dispersion Formula

Data for BK9:

- $c_1=0.028$
- $c_2=1.56328$
- $c_3=0.0188168$
- $c_4=-0.0925687$
- $c_5=-0.00111742$
- $c_6=-0.0000432504$
- $c_7=0.000167343$
- $c_8=0$
- $c_9=0$
- $c_{10}=0$
- $c_{11}=0$

source: GlassBank website

<http://glassbank.ifmo.ru/eng/prop.php?id=318>

Material Name: BK9 by Reznik

Refractive Index | Absorption Coefficient | Additional Information | Temperature Data

Define Refractive Index by

Dispersion Formulas
Programmable (dropdown) $n = \text{calc}(\lambda)$

Sampled Dispersion
 Constant

Data

Relative to Reference Material [Set]

Definition

[Edit] Validity: ✓

Parameters

C1	0.028
C2	1.56328
C3	0.0188168
C4	-0.0925687
C5	-0.00111742
C6	-0.000432504

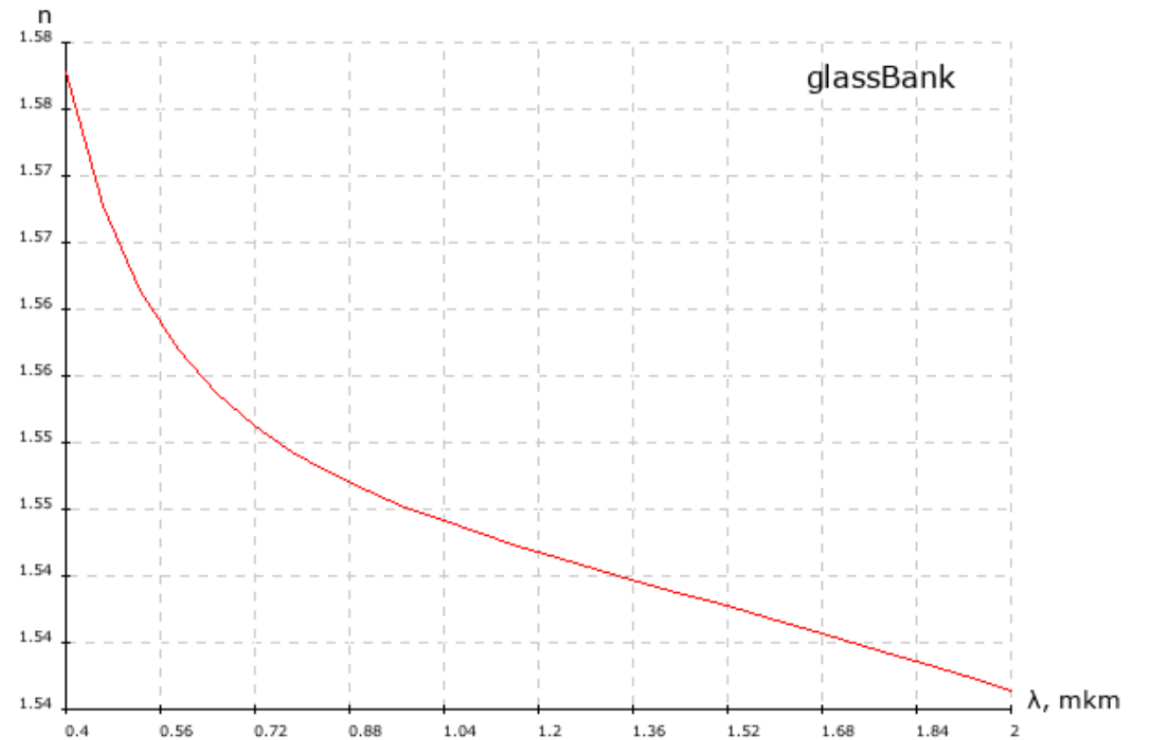
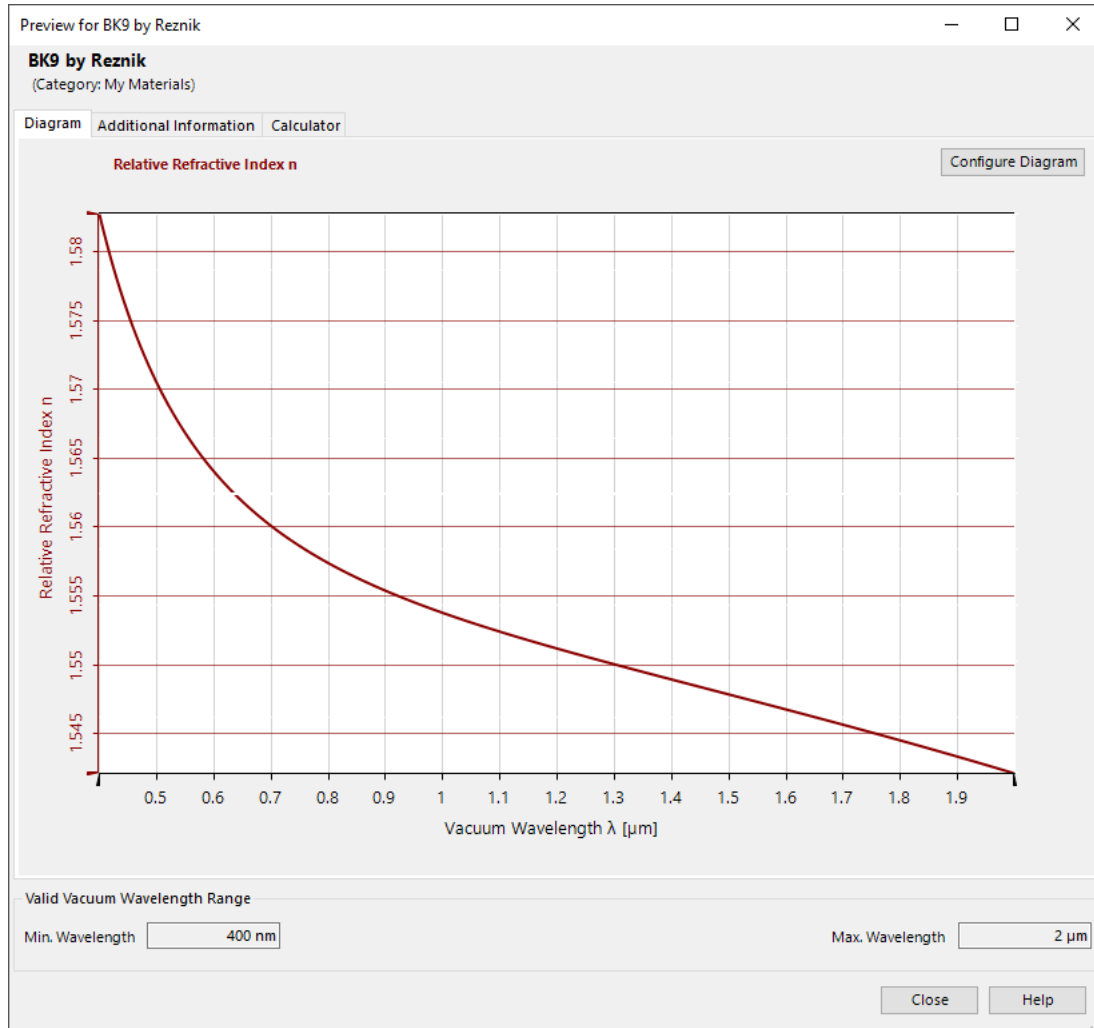
Domain of Definition

Vacuum Wavelength Range: 365.01 nm to 2.6 μm

Usable Vacuum Wavelength Range: 365.01 nm to 2.6 μm

Tools | Validity: ✓ | Ok | Cancel | Help

Comparison for GOST BK9



source: GlassBank website

http://glassbank.ifmo.ru/eng/n_wl_graf.php?id=318

Document Information

title	Programmable Dispersion Function
document code	SWF.0026
document version	1.0
software edition	VirtualLab Fusion Basic
software version	2023.1 (Build 1.544)
category	Feature Use Case
further reading	<ul style="list-style-type: none">• <u>Import of Material Data to VirtualLab Fusion</u>

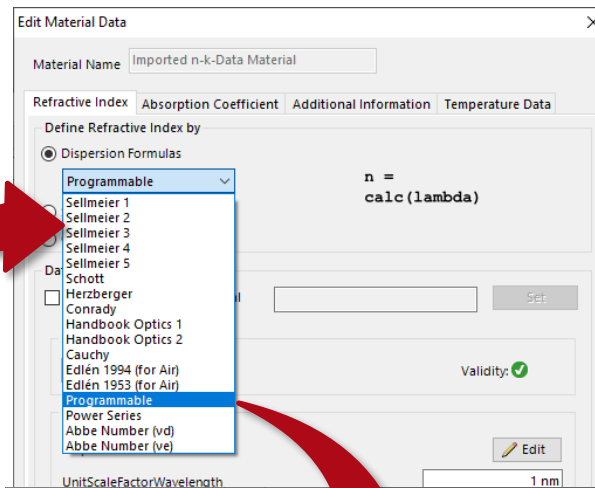
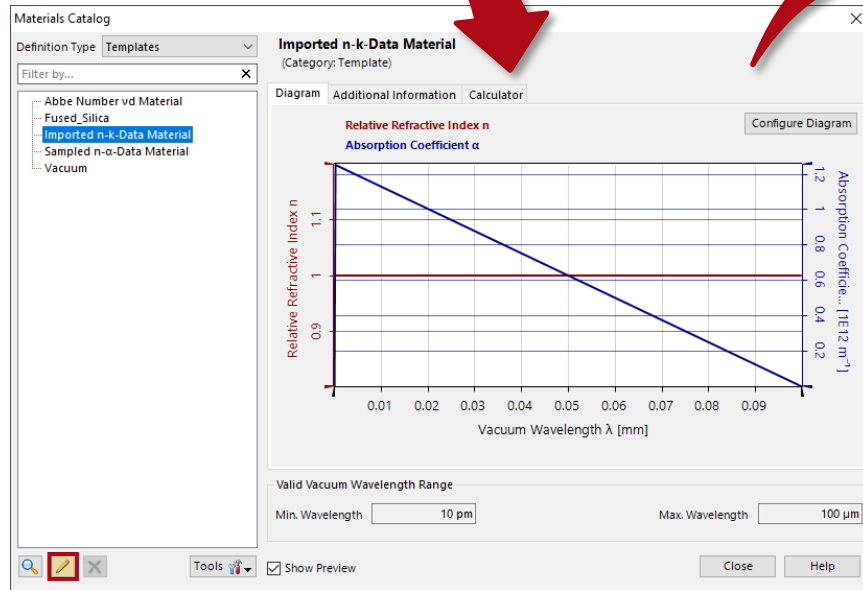
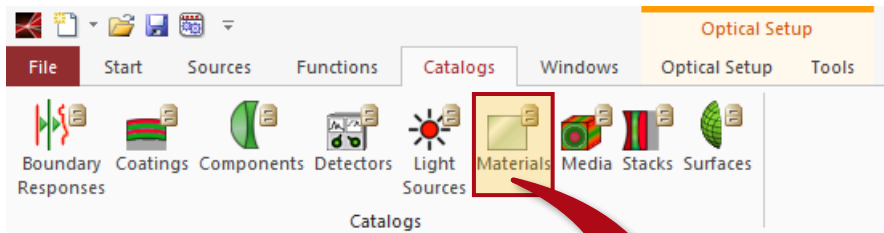
Keywords

- SWF.0026, Materials, Media, Catalog, Medium Catalog, Material Catalog, Customization, Medium, Material, Dispersion, Dispersion Formula, Reznik, Reznik Dispersion, Reznik Dispersion Formula

Short Abstract

- This Use Case introduces the Programmable Medium and shows how to customize your own dispersion Formula.

Marketing Picture



Source Code Editor

Source Code Global Parameters Snippet Help Advanced Settings

```
1  Preset using directives
26
27  #region Additional using directives
28
29  #endregion
30
31  public class VLModule : ISnippetDouble_Double_Wavelength_Double_Temperature_Double_Pressure {
32
33      Global Parameters
34
35
36
37
38
39
40
41
42
43
44
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46
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50
51
52  public double GetData(double Wavelength, double Temperature, double GasPressure) {
53
54      #region Main method
55
56      //rescaling wavelength to um
57      double wavelength = Wavelength * 1e6;
58      double maximumWavelength = MaximumWavelength * 1e6;
59      double minimumWavelength = MinimumWavelength * 1e6;
60
61      //defining helping variables
62      double L = 1 / (Math.Pow(wavelength, 2) - C1);
63      double Lmin = 1 / (Math.Pow(minimumWavelength, 2) - C1);
64      double Lmax = 1 / (Math.Pow(maximumWavelength, 2) - C1);
65      double L_av = (Lmax + Lmin) / 2;
66      double DeltaL = (Lmin - Lmax) / 2;
67
68      double Lambda_av = (Math.Pow(maximumWavelength, 2) + Math.Pow(minimumWavelength, 2)) / 2;
69      double DeltaLambda = (Math.Pow(maximumWavelength, 2) - Math.Pow(minimumWavelength, 2)) / 2;
70
71      double mu = (L - L_av) / DeltaL;
72      double nu = (Math.Pow(wavelength, 2) - Lambda_av) / DeltaLambda;
73
74      //calculation of refractive index
75      double refractiveIndex = C2 + C4 * nu + C6 * Math.Pow(nu, 2) + C8 * Math.Pow(nu, 3) + C10 * Math.Pow(nu, 4)
76      + C3 * mu + C5 * Math.Pow(mu, 2) + C7 * Math.Pow(mu, 3) + C9 * Math.Pow(mu, 4) + C11 * Math.Pow(mu, 5);
77
```

MinimumWavelength [double]

MaximumWavelength [double]

Wavelength [double]

Temperature [double]

GasPressure [double]

C1 [double]

C2 [double]

C3 [double]

C4 [double]

C5 [double]

C6 [double]

C7 [double]

C8 [double]

C9 [double]

C10 [double]

C11 [double]

Check Consistency Validity:

OK Cancel Help