Guideline to Daylight Simulations with MicroShade®

This is a guideline to daylight simulations with MicroShade®. The guideline describes how to use MicroShade® Radiance files and MicroShade® BSDF files. The guideline assumes that the user know which of the two methods could be used in their chosen daylight simulation software. The guideline is therefore not intended for any specific software. Please contact you program supplier for support on your program. For questions regarding daylight simulations with MicroShade® please contact us at support@microshade.dk

About MicroShade®

MicroShade® is a highly effective shading product containing microscopic shading lamellas. The shading efficiency depends on the incidence angle of the sun on the lamellas. When the sun is high in the sky during the summer, MicroShade® provides the strongest shading and during winter when the sun is low more heat is allowed into the building. Similarly, the shading efficiency also varies during the course of the day due to the different positions of the sun morning, noon and evening.

Selection of MicroShade® type

For façade applications two MicroShade® product types are commonly used – the MicroShade® MS-A and MS-D. Aesthetically, these are similar, only the MS-D provides a stronger shading whilst the MS-A allows more daylight inside. For roof applications, MS-RS and MS-RW are typically used. MS-RS is recommended in pitches up to 30˚, and MS-RW is recommended for pitches between 30˚ and 60˚. For more information on selection of MicroShade® type please see our selection guidelines on www.microshade.net/downloads-software

Rotation of MicroShade®

A rotation of MicroShade® can be done to optimize the g-value. For vertical facades MicroShade® are never rotated, while MicroShade® in roof windows can be rotated depending on the orientation and tilt of roof. Rotation should be considered for MS-RW for orientations between northeast (45˚) and northwest (315˚) for all roof windows. Please contact MicroShade A/S at support@microshade.dk in these cases to get the right rotation angle.

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¹ Facade application means glazing mounted in a near vertical position.

MicroShade® daylight model

The MicroShade® model is a description of only the MicroShade® layer. In order to model MicroShade® in a window two polygons are needed; the outer polygon is the MicroShade® layer and the inner polygon is the glazing. The two polygons together model the MicroShade® window. The surface normal of the polygon representing MicroShade® should face the exterior, see figure 1.
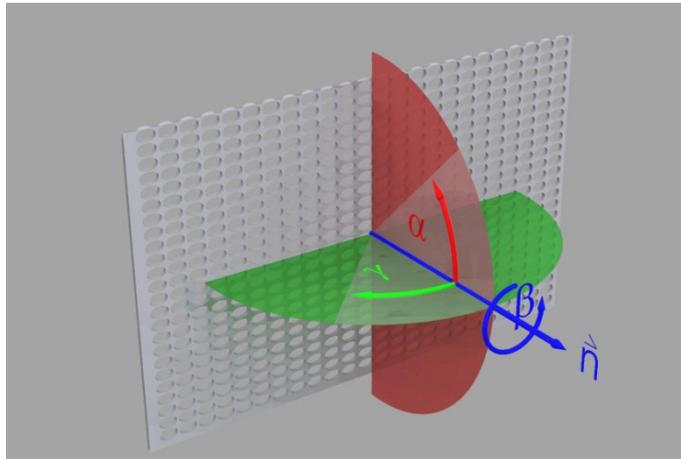

Figure 1. The surface normal should face the exterior.

The material description for the glazing is the same as without MicroShade®.

Since MicroShade® is a complex shading structure (as complex as venetian blinds) it is recommended to set simulation parameters to a high quality.

Daylight metrics

The different daylight simulation programs offer different daylight metrics for evaluation of the daylight conditions in a room or building.

Most common is the Daylight Factor (DF), Useful Daylight Illuminance (UDI), Daylight Autonomy (DA), Continuous Daylight utonomy (cDA) and Spatial Daylight Autonomy (sDA). Furthermore some programs can calculate the Daylight Glare Probability (DGP). All except the Daylight Factor are climate based metrics, where climate data are used to simulate every hour of a year.

The daylight factor (DF) is a very simple daylight assessment method performed at a CIE standard overcast sky. A one point in time measure at an artificial sky is a very coarse evaluation of the varying daylight conditions experienced in reality. Therefore it is **not** recommended to use the daylight factor for evaluation of the daylight conditions.

Useful Daylight Illuminance (UDI) describes how many hours, workhours or percentage of the year where the daylight levels are within the desired interval, usually 100-3000 lux. Lower illuminance levels requires artificial light and higher illuminance levels causes a risk of overheating and glare.

Daylight Autonomy (DA) and the two sister-metrics cDA and sDA all describes how many hours, workhours or percentage of the year where the daylight levels are above a certain (lower)limit, usually somewhere between 100- 500 lux. The continous Daylight Autonomy (cDA) also take illuminance level below the treshold into account by weighting it. Spatial Daylight Autonomy (sDA) consider how many % of the floor area the desired DA is obtained.

Daylight Glare Probability (DGP) is a meaure of the probability of glare from daylight during the year. Values below 0.35 is imperceptible glare, while values above 0.45 is intolerable glare.

MicroShade® Radiance model

Radiance models of MicroShade® type MS-A, MS-D, MS-RW and MS-RS has been developed by Fraunhofer Institute for Solar Energy Systems. The models have been validated against angle dependent transmittance measurements.

Usage of MicroShade® Radiance model

The material description for MicroShade® is enclosed in the following files. To download click on the appropriate MicroShade® type below. Remember to also download the material file (.rad).

- Microshade_a.cal (Used in south facing facades)
- Microshade_d.cal (Used in south, east and west facing facades)
- Microshade_rs.cal (Used in roofs with inclination <30˚)
- Microshade_rw.cal (Used in roofs with inclination between 30˚ and 80˚
- Microshade_mat.rad

The .cal files should be stored in the Radiance library "lib". The text in the MicroShade_mat.rad file should be copied into the material file in Radiance.

The letters behind underscore e.g. "MicroShade_a" represent the different types of MicroShade® - in this case MS-A.

The MicroShade_mat.rad file contains the following:

```
void glass microshade_air
0
0
4 1 1 1 1

void plastic microshade_metal
0
0
5 0.1 0.1 0.1 0.017 0.005

void mixfunc microshade_a_mat
4  microshade_air microshade_metal trans microshade_a.cal
0
1 0
```

Rotation angle ß,= no rotation, 90=90˚ rotation anticlockwise, 180 (upside down)= 180˚, 270= 270˚ rotation anticlockwise seen from the exterior

If another type of MicroShade is used the text marked in green should be exchanged with the relevant MicroShade® type.

For a façade window with MicroShade® the structure is "open" downward and "closed" upward, due to the tilt of the microlamellas in MicroShade®. In case of a horizontal window with MicroShade® it is important to notice that the structure is "open" towards negative x-direction and "closed" towards positive x-direction in the window coordination system as default.

MicroShade® BSDF files

BSDF (Bi-Directional-Scattering-Function) files of MicroShade® have been developed together with the Laboratory of Performance-Integrated Design at EPFL in Lausanne Switzerland. The models have been validated against angle dependent transmittance measurements.

Usage of MicroShade® BSDF files

The BSDF file for MicroShade® is enclosed in the following files. To download a BSDF file, click on the appropriate MicroShade® type below.

- – MS-A (Used in south facing facades)
- – MS-D (Used in east and west facing facades)
- – MS-RS (Used in roofs with inclination <30˚)
- – MS-RW (Used in roofs with inclination between 30˚ and 80˚)
    - MS-RW 90˚ - MS-RW rotated 90˚
    - MS-RW 180˚ - MS-RW rotated 180˚
    - MS-RW 270˚ - MS-RW rotated 270˚

In some simulation programs it is not possible to simulate MicroShade® as a separate layer. In these cases it is necessary to combine MicroShade® with a glazing. This can be done in e.g. Windows 7. Please see the section "Creating a BSDF file for a glazing with MicroShade® in Window 7".

Creating a BSDF file for a glazing with MicroShade® in Window 7

About Window 7

Window 7 is a window program that calculates specifications (U-value, transmission, reflection etc.) for glazings and complex glazing systems with shadings. Window 7 is developed at Lawrence Berkeley National Laboratory (LBNL) in California, USA and contains the international glazing database (IGDB) with more than 3800 glazings.

Window 7 can be used to build-up any glazing including shading systems to be used for energy or daylight analysis in other programs like e.g. Radiance or IESVE. For complex fenestration systems like MicroShade® the output is a XML BSDF file containing the angular depended transmittance and reflectance of the glazing including MicroShade®. Programs that can read XML BSDF files can also use the files created in Window 7.

Glazing build up with MicroShade®

To implement MicroShade® in a window, the coatings of the glazing need to be placed on the correct surfaces in the glazing. MicroShade® is implemented on the first pane of the glazing, on the interior surface referenced to as surface "2" in Fig. 2. Low-E coatings should be places on surface 3 and 5. The distance between the pane and the MicroShade® layer should be set to 0.05 mm.
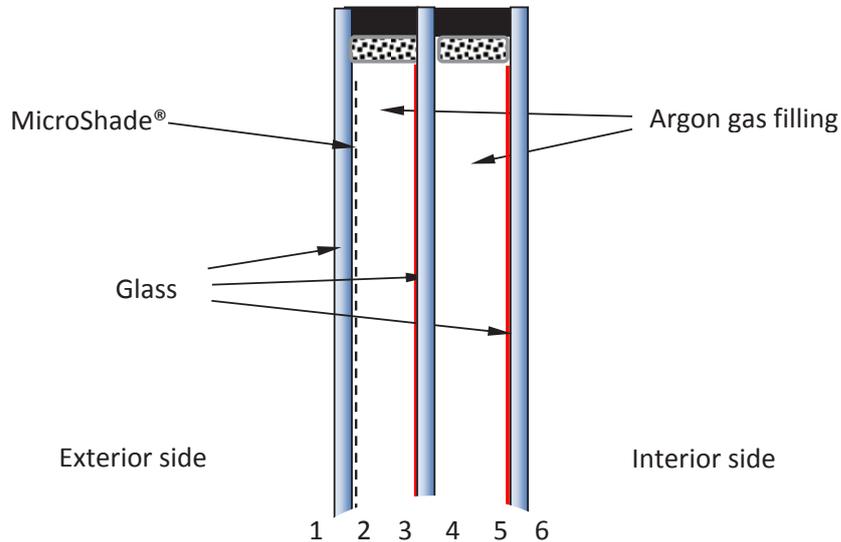

Figure 2. A glazing composition of a 3-layer LowE glazing with MicroShade®.
The numbers indicate the indexing of the glazing surfaces.

Import the MicroShade® BSDF file to Window 7

1. Go to the shading layer Library; "Libraries" > "Shading Layer" or click on the Shading Layer Library icon in the menu bar.

2. In the left menu bar click on "New". A new window will open up and prompt for an ID number for the new record. Just use the number suggested and press "OK".

3. The new record you just created will show on the last line in the list. Double click on it and a new window will open up. See figure 3.
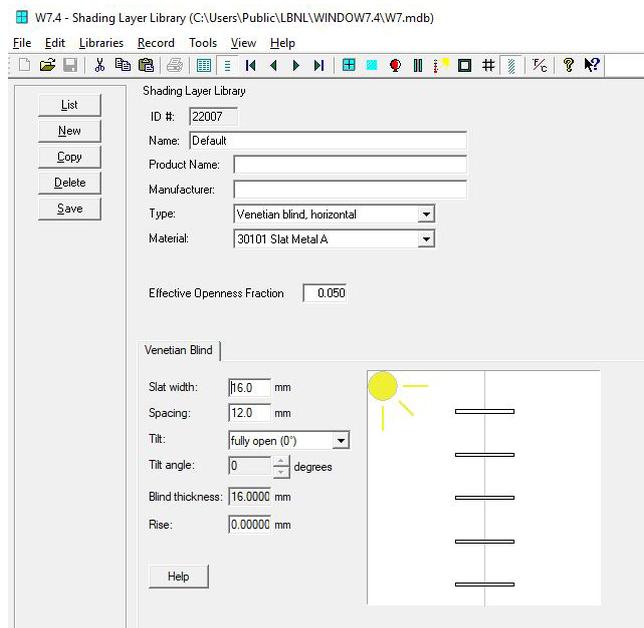

Figure 3: New Shading Layer Record.

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4. In the "Type" drop-down menu choose the "Shade with XML data".

5. Click "Browse" and choose the MicroShade® BSDF file you want to import. Values will now appear in the table. See figure 4.

Please note: The thickness will show as 0.000, but if the BSDF file is opened it can be seen that the actual thickness of the product is 0.000175 m.
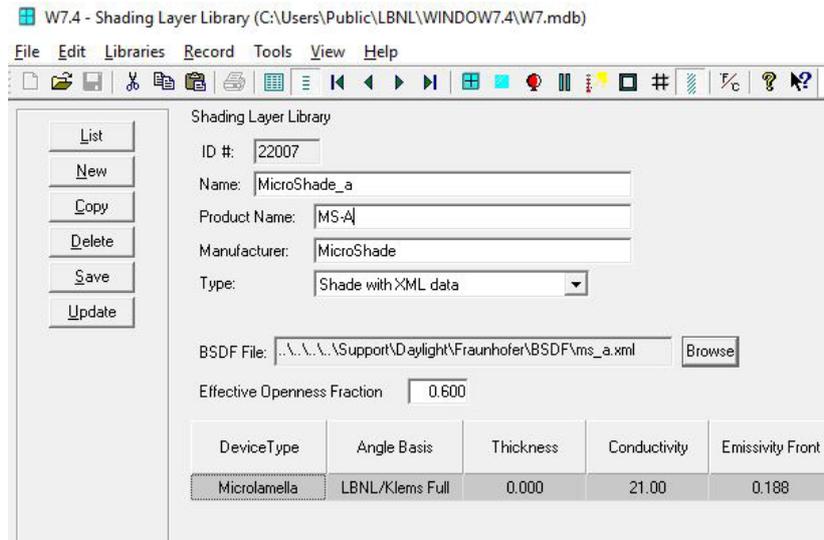

Figure 4: MicroShade® BSDF file has been imported.

6. Save the new shading layer you just created.

Create a glazing with MicroShade® BSDF file

1. Go to the Glazing System Library; "Libraries" > "Glazing System" or click on the Glazing System icon in the menu bar.

2. In the left menu click on "New". A new window will open up and prompt for an ID number for the new record. Just use the number suggested and press "OK". The new record you just created will show in a pop-up window.
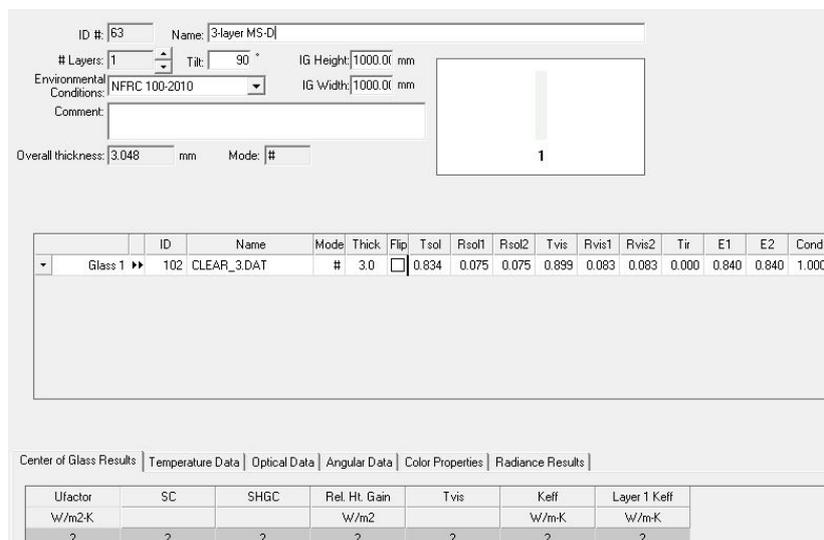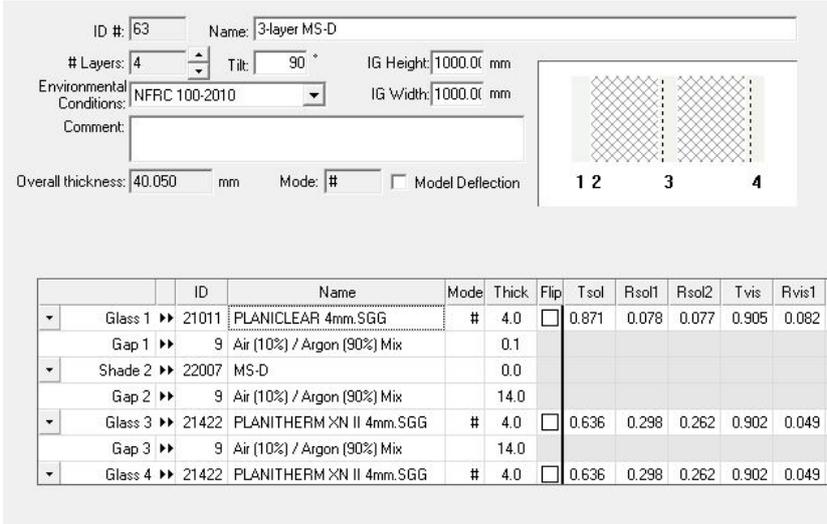

Figure 5: New Glazing System record.

3. Type in the name of your new glazing and choose the number of layers. The MicroShade® layer should be added to the number of glass layers. If you want to make a 2-layer glazing with MicroShade®, choose 3 layers and for a 3-layer glazing with MicroShade® choose 4 layers.

4. Each layer can now be modified to the desired glazing build up. Glass 2 should be changed to a shading layer and the new MicroShade® shading layer should be chosen. Gap no. 1 should have a thickness of 0.05 and the same filling as gap no 2. See. Figure 6 for an example.

Please note: Remember to place the low-e coating on side 3 (and 5) in the MicroShade® glazing.

Figure 6: Example of a 3-layer MicroShade® glazing. Please note the position of the low-e coating on side 3 and 5.

5. Once you have build-up your glazing, you are ready to calculate the value for the glazing including MicroShade®. As default boundary conditions the standard NFRC 100-2010 is used. The boundary conditions are only relevant for U- and g-value calculations and are not important for generation of the new BSDF file.

6. Go to the left menu bar and click "Calc". A pop up window will show up while the values are being calculated.

7. Save the record, when the values have been calculated.

8. To generate the new BSDF file with MicroShade® included in the glazing go to the left menu and press "Report". Chose "Energy Plus BSDF IDF File" in the drop down menu and save the file on your desired location. The file format is ".IDF" and can be used directly in EnergyPlus. In case you need another BSDF file format open the file in "Note" and format the file to the desired format.

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