

Subsurface Scattering Material | V-RayMtlSSS

This page provides information on the V-RayMtlSSS node.

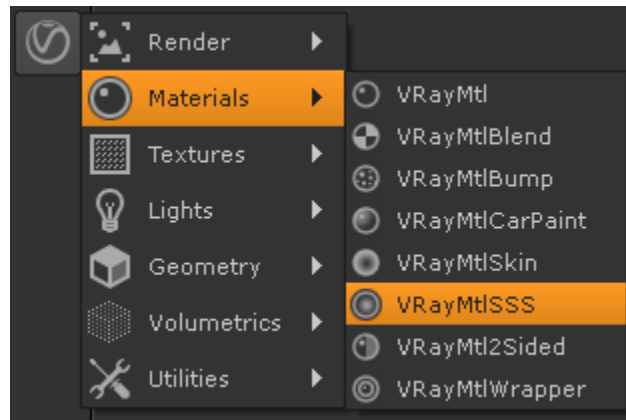
Overview

V-RayMtlSSS is a material that is primarily designed for rendering of translucent materials like skin, marble etc. The implementation is based on the concept of BSSRDF originally introduced by Jensen et al. (see the [references](#) below) and is a more or less physically accurate approximation of the sub-surface scattering effect, while still being fast enough to be used in practice.

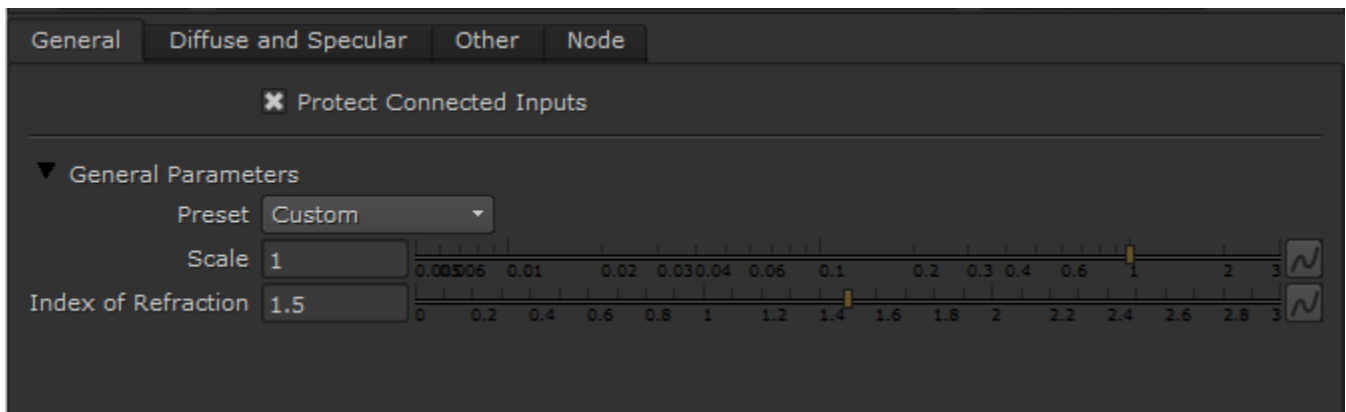
The V-RayMtlSSS is a complete material with diffuse and reflection components that can be used directly, without the need of a [V-RayBlendMtl](#) material. More exactly, the material is composed of three layers: a reflection layer, a diffuse layer, and a sub-surface scattering layer. The sub-surface scattering layer is comprised of single and multiple scattering components. Single scattering occurs when light bounces once inside the material. Multiple scattering results from light bouncing two or more times before leaving the material.



UI Path: `||Toolbar|| > V-Ray menu icon > Materials > V-RayMtlSSS`



General



Preset – Allows you to choose one of several available preset materials. Most of the presets are based on measured data provided by *Jensen et al.* in **A Practical Model for Subsurface Light Transport**.

Scale – Additionally scales the subsurface scattering radius. Normally, VRayMtlSSS will take the scene units into account when calculating the subsurface scattering effect. However, if the scene was not modeled to scale, this parameter can be used to adjust the effect. It can also be used to modify the effect of the presets, which reset the **Scatter radius** parameter when loaded, but leave the **Scale** parameter unchanged. *For more information, see the [Scale example](#) below.*

Index of Refraction – The index of refraction for the material. Most water-based materials like skin have an index of refraction of about 1.3.

Example: VRayMtlSSS Presets



Skin Brown



Skin Pink



Skin Yellow



Milk [Skim]



Milk [Whole]



Marble [White]



Ketchup



Cream



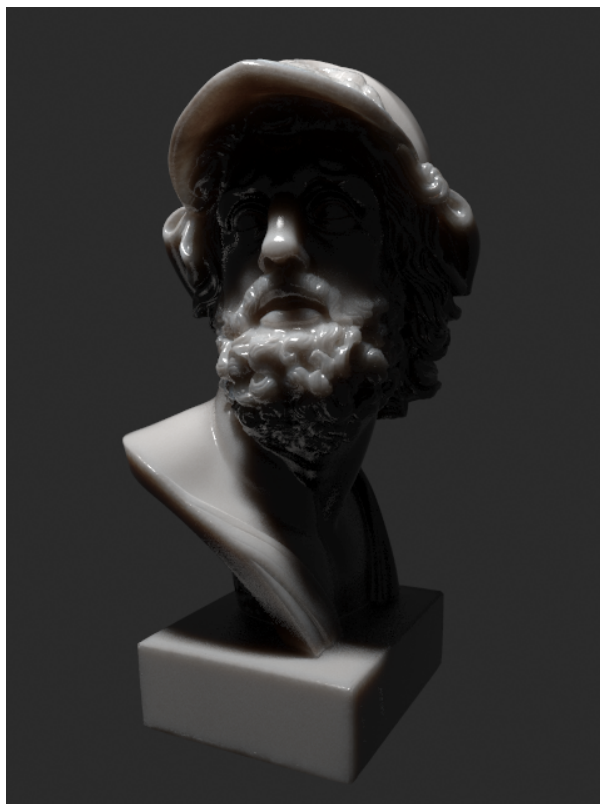
Potato



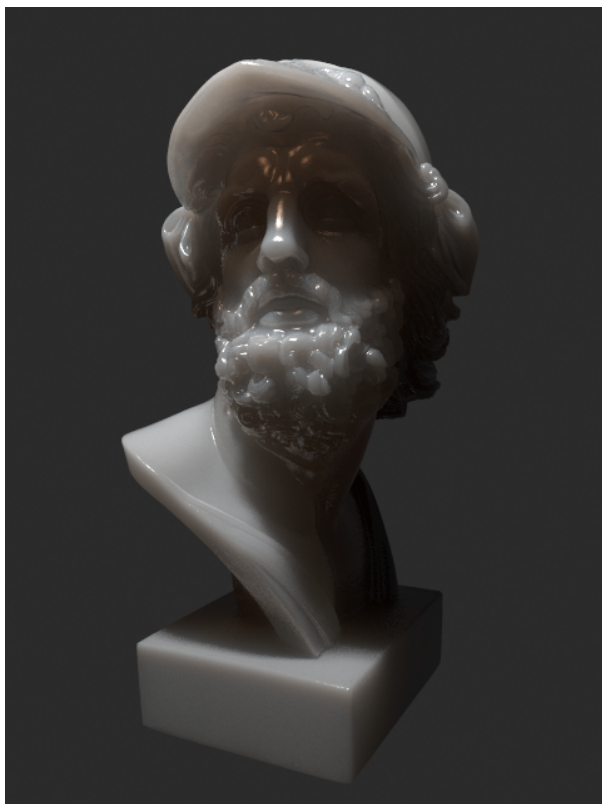
Spectralon

Example: Scale

This example shows the effect of the Scale parameter. Note how larger values make the object appear more translucent. In its effect, this parameter does essentially the same thing as the Scatter radius parameter, but it can be adjusted independently of the chosen preset. The images are rendered without GI to better show the sub-surface scattering. The Single scatter parameter was set to Raytraced (solid). The Marble (white) preset was used for all images.



Scale = 1

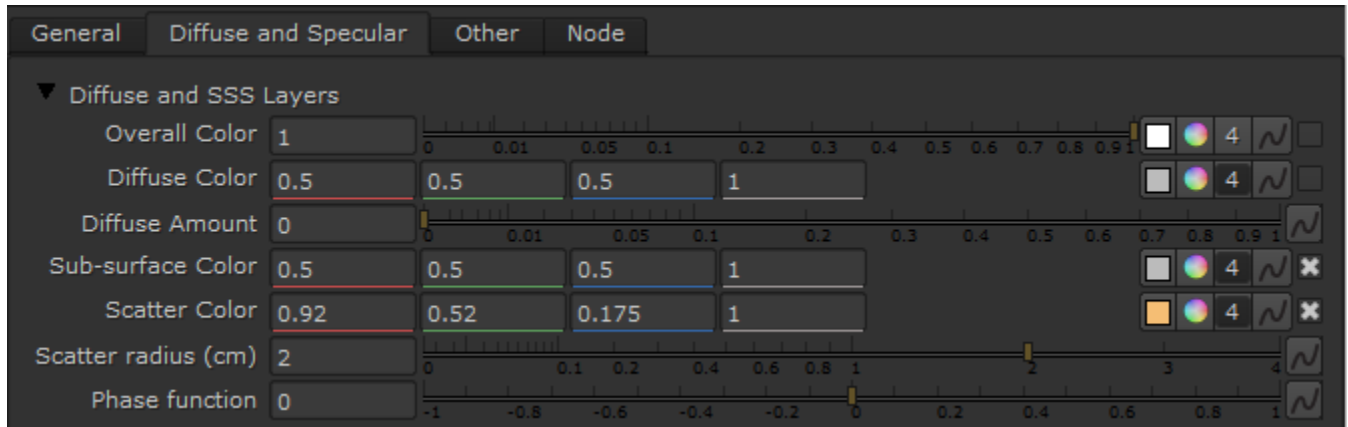


Scale = 10



Scale = 100

Diffuse and SSS Layers



Overall Color – Controls the overall coloration for the material. This color serves as a filter for both the diffuse and the sub-surface component.

Diffuse Color – The color of the diffuse portion of the material.

Diffuse Amount – The amount for the diffuse component of the material. Note that this value in fact blends between the diffuse and sub-surface layers. When set to 0.0, the material does not have a diffuse component. When set to 1.0, the material has only a diffuse component, without a sub-surface layer. The diffuse layer can be used to simulate dust etc. on the surface.

Sub-surface Color – The general color for the sub-surface portion of the material. *For more information, see the [Sub Surface Color example](#) below.*

Scatter Color – The internal scattering color for the material. Brighter colors cause the material to scatter more light and to appear more translucent; darker colors cause the material to look more diffuse-like. *For more information, see the [Scatter Color example](#) below.*

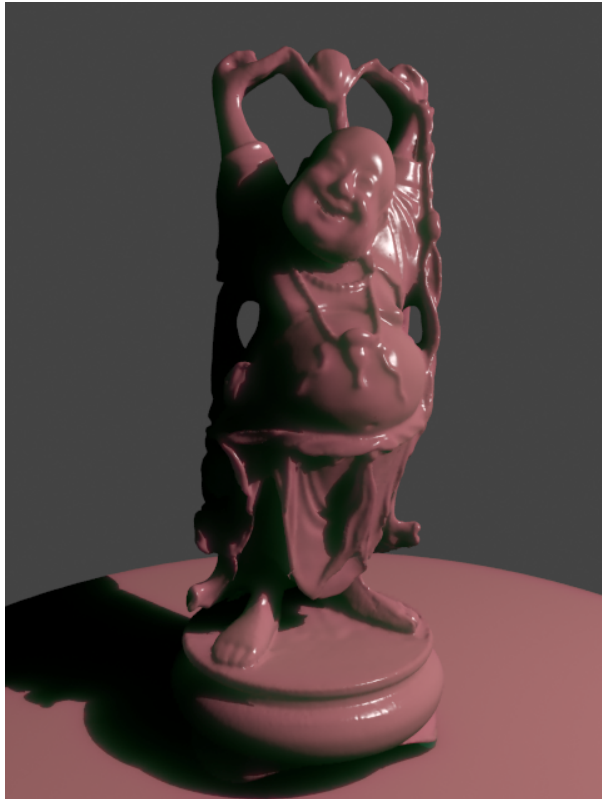
Scatter radius (cm) – Controls the amount of light scattering in the material. Smaller values cause the material to scatter less light and to appear more diffuse-like; higher values make the material more translucent. Note that this value is specified always in centimeters (cm); the material will automatically take care to convert it into scene units based on the currently selected system units. *For more information, see the [Scatter Radius example](#) below.*

Phase function – A value between -1.0 and 1.0 that determines the general way light scatters inside the material. Its effect can be somewhat likened to the difference between diffuse and glossy reflections from a surface, however the phase function controls the reflection and transmittance of a volume. A value of 0.0 means that light scatters uniformly in all directions (isotropic scattering); positive values mean that light scatters predominantly forward in the same direction as it comes from; negative values mean that light scatters mostly backward. Most water-based materials (e.g. skin, milk) exhibit strong forward scattering, while hard materials like marble exhibit backward scattering. This parameter affects most strongly the single scattering component of the material. Positive values reduce the visible effect of single scattering component, while negative values make the single scattering component generally more prominent. *For more information, see the [Phase Function example](#) and the [Phase Function: Light Source example](#) below.*

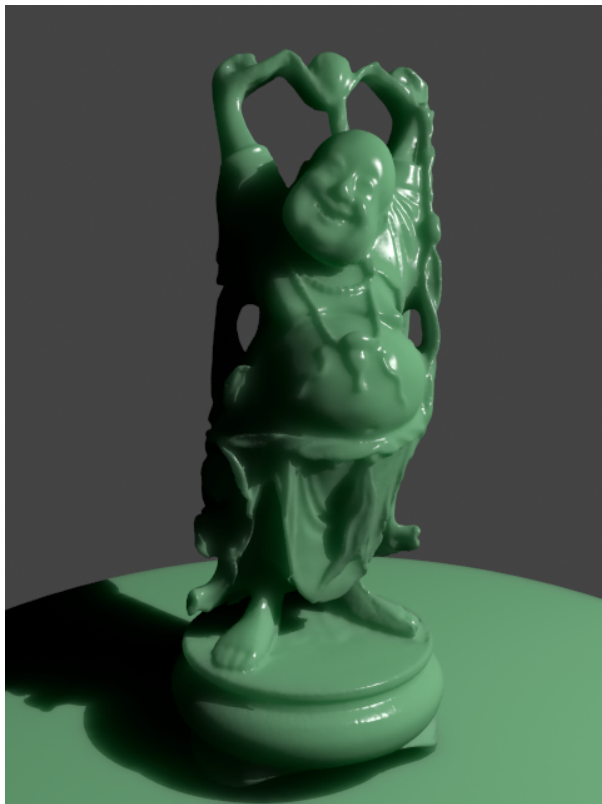
Example: Sub Surface Color

This example and the next demonstrate the effect of and the relation between the Scatter color and the Sub-surface color parameters. Note how changing the Sub-surface color changes the overall appearance of the material, whereas changing the Scatter color only modifies the internal scattering component.

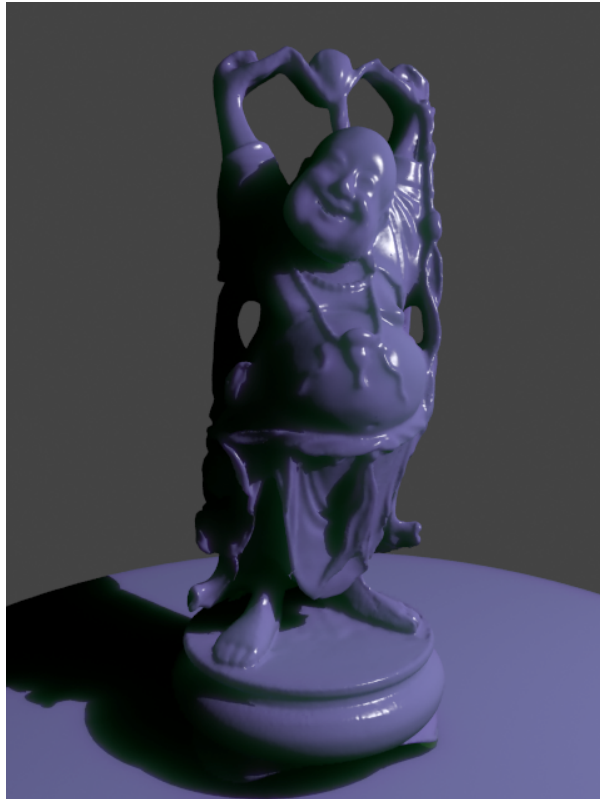
The Scatter color is set to green.



Sub Surface Color = Red



Sub Surface Color = Green

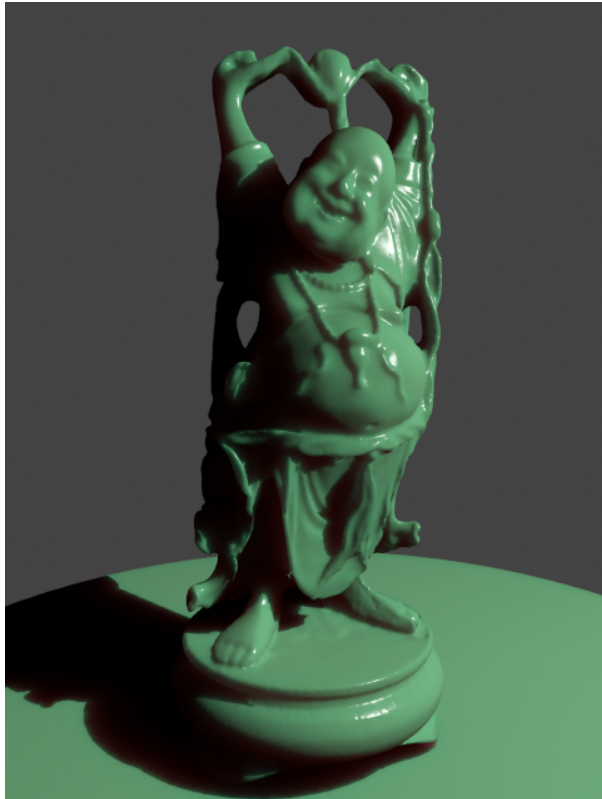


Sub Surface Color = Blue

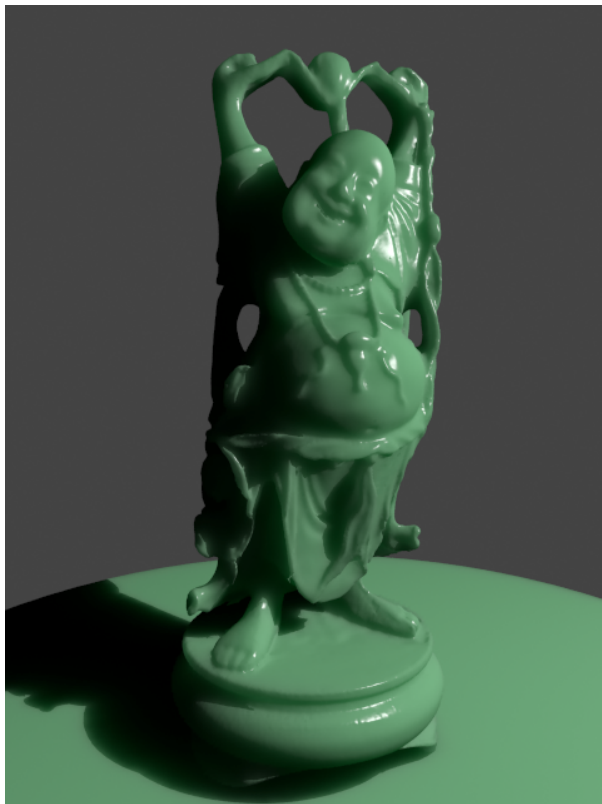
Note: the "happy buddha" model is from the Stanford scanning repository (<http://graphics.stanford.edu/data/3Dscanrep/>).

Example: Scatter Color

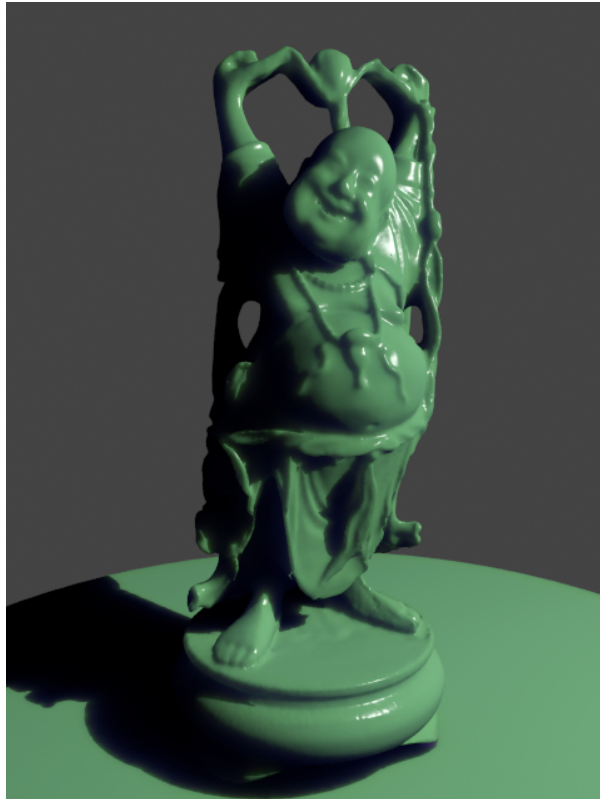
The Sub-surface color is kept to green.



Scatter Color = Red



Scatter Color = Green



Scatter Color = Blue

Note: the "happy buddha" model is from the Stanford scanning repository (<http://graphics.stanford.edu/data/3Dscanrep/>).

Example: Scatter Radius

This example shows the effect of the Scatter radius parameter. Note that the effect is the same as increasing the Scale parameter, but the difference is that the Scatter radius is modified directly by the different presets.

This set of images is based on the Milk (skimmed) preset.

The cube in the lower left corner has a side of 1cm.



Scatter Radius = 1.0cm



Scatter Radius = 2.0cm



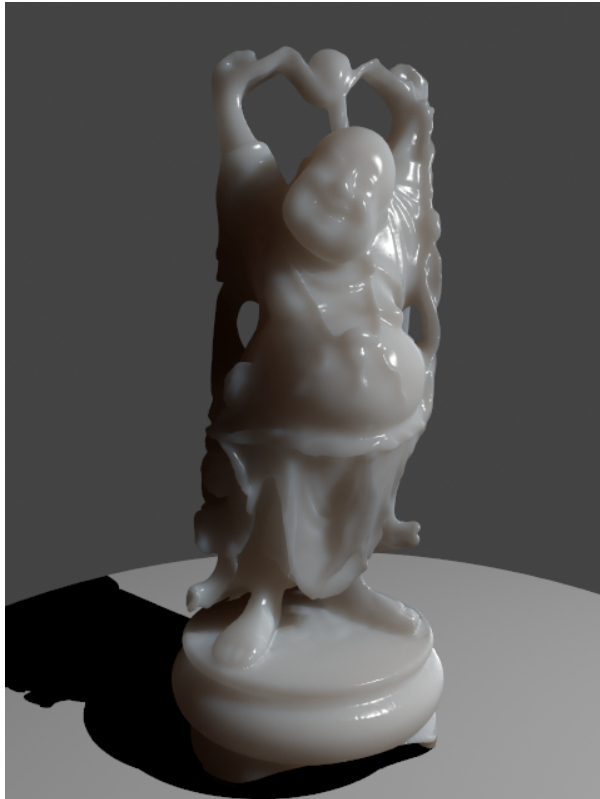
Scatter Radius = 4.0cm

Note: the "happy buddha" model is from the Stanford scanning repository (<http://graphics.stanford.edu/data/3Dscanrep/>).

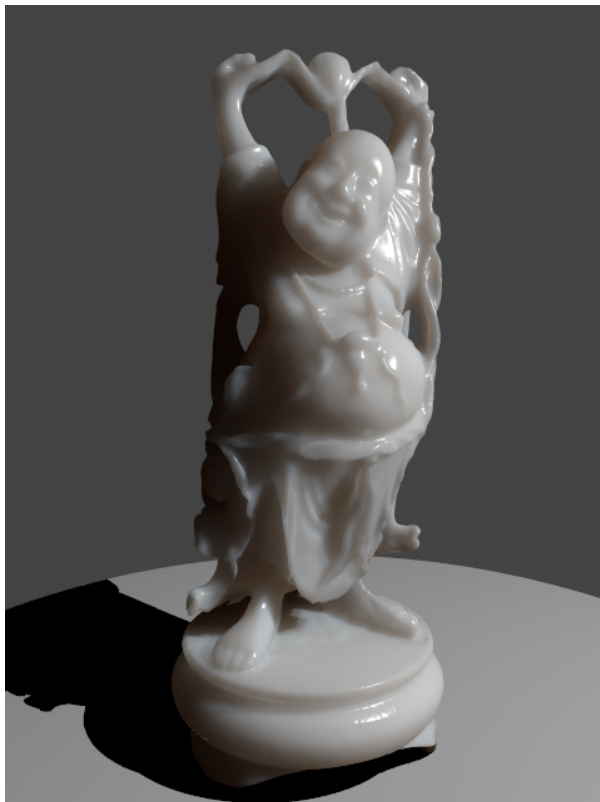
Example: Phase Function

This example shows the effect of the Phase function parameter. This parameter can be likened to the difference between diffuse reflection and glossy reflection on a surface, however it controls the reflectance and transmittance of a volume. Its effect is quite subtle, and mainly related to the single scattering component of the material.

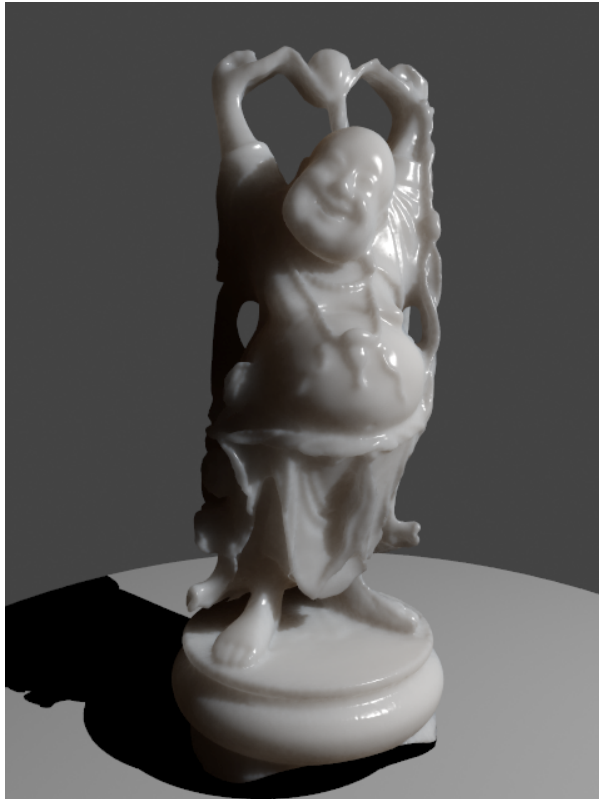
The red arrow represents a ray of light going through the volume; the black arrows represent possible scattering directions for the ray.



Phase Function = -0.9 (Backward Scattering)
More light comes out.



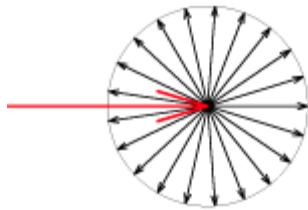
Phase Function = 0 (Isotropic Scattering)
More light exits object.



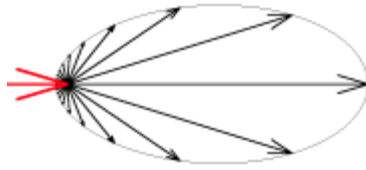
Phase Function = 0.5 (Forward Scattering)
More light is absorbed object.



Phase Function = -0.5 (Backward Scattering)



Phase Function = 0 (Isotropic Scattering)



Phase Function = 0.5 (Forward Scattering)

Note: the "happy buddha" model is from the Stanford scanning repository (<http://graphics.stanford.edu/data/3Dscanrep/>).

Example: Phase Function: Light Source

This example demonstrates the effect of the Phase function parameter when there is a light source inside the volume. The images are based on the Skin (pink) preset with large Scatter radius and Raytraced (refractive) mode for single scattering with IOR set to 1.0. Front lighting and Back lighting are disabled for these images; only single scattering is visible. Note the volumetric shadows cast by the light inside the volume.



Phase Function = -0.9

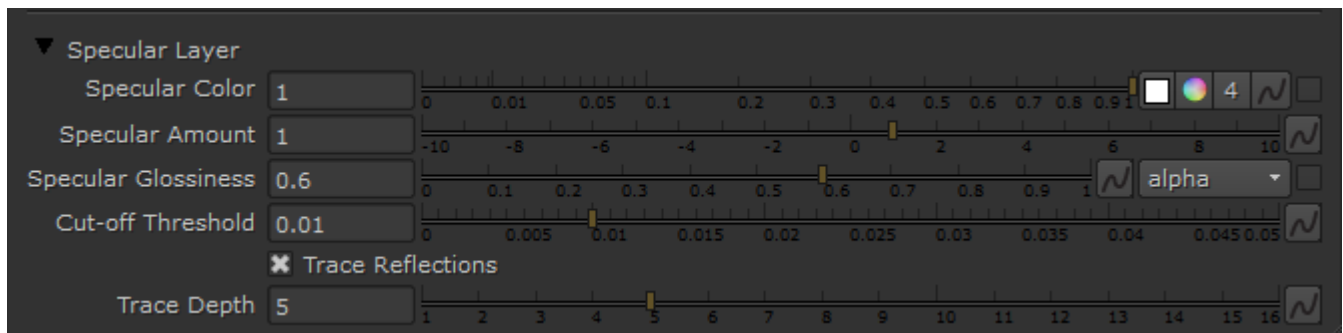


Phase Function = 0



Phase Function = 0.5

Specular Layer Parameters



Specular Color – Determines the specular color for the material.

Specular Amount – Determines the specular amount for the material. Note that there is an automatic Fresnel falloff applied to the specular component, based on the **IOR** of the material.

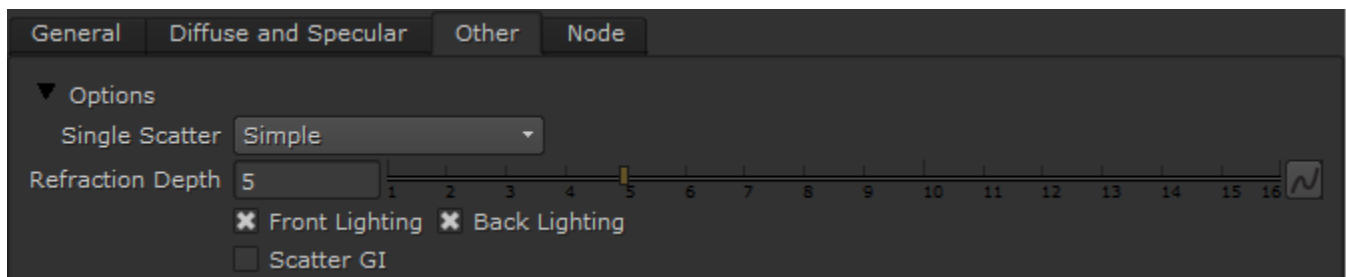
Specular Glossiness – Determines the glossiness (highlights shape). A value of 1.0 produces sharp reflections, lower values produce more blurred reflections and highlights.

Cut-off Threshold – A threshold below which reflections will not be traced. V-Ray tries to estimate the contribution of reflections to the image, and if it is below this threshold, these effects are not computed. Do not set this to 0.0 as it may cause excessively long render times in some cases.

Trace Reflections – Enables the calculations of glossy reflections. When off, only highlights will be calculated.

Trace Depth – The number of reflection bounces for the material.

Options



Single Scatter – Controls how the single scattering component is calculated:

None – No single scattering component is calculated.

Simple – The single scattering component is approximated from the surface lighting. This option is useful for relatively opaque materials like skin, where light penetration is normally limited.

Raytraced (solid) – The single scattering component is accurately calculated by sampling the volume inside the object. Only the volume is raytraced; no refraction rays on the other side of the object are traced. This is useful for highly translucent materials like marble or milk, which at the same time are relatively opaque.

Raytraced (refractive) – Similar to the Raytraced (solid) mode, but in addition refraction rays are traced. This option is useful for transparent materials like water or glass. In this mode, the material will also produce transparent shadows.

Refraction Depth – This determines the depth of refraction rays when the **Single scatter** parameter is set to Raytraced (refractive) mode.

Front Lighting – Enables the multiple scattering component for light that falls on the same side of the object as the camera.

Back Lighting – Enables the multiple scattering component for light that falls on the opposite side of the object as the camera. If the material is relatively opaque, turning this off will speed up the rendering.

Scatter GI – Controls whether the material will accurately scatter global illumination. When off, the global illumination is calculated using a simple diffuse approximation on top of the sub-surface scattering. When on, the global illumination is included as part of the surface illumination map for multiple scattering. This is more accurate, especially for highly translucent materials, but may slow down the rendering quite a bit.

Example: Single Scatter Mode

This example shows the effect of the Single scatter mode parameter.

For relatively opaque materials, the different Single scatter modes produce quite similar results (except for render times). In the following set of images, the Scatter radius is set to 0.5 cm.

In the second set of images, the Scatter radius is set to 50.0 cm. In this case, the material is quite transparent, and the difference between the different Single scatter modes is apparent. Note also the transparent shadows with the Raytraced (refractive) mode.



Single Scatter = Simple



V-Ray Adv 1.50.SP3 | render time: 0h 1m 33,4s

Single Scatter = Ray Traced Solid



V-Ray Adv 1.50.SP3 | render time: 0h 1m 53,0s

Single Scatter = Ray Traced Refractive



V-Ray Adv 1.50.SP3 | render time: 0h 0m 21,5s

Single Scatter = Simple



V-Ray Adv 1.50.SP3 | render time: 0h 0m 41,6s

Single Scatter = Ray Traced Solid



Single Scatter = Ray Traced Refractive

Note: the "happy buddha" model is from the Stanford scanning repository (<http://graphics.stanford.edu/data/3Dscanrep/>).

References

Here is a list of references used when building the V-RayMtlSSS material.

- H. C. Hege, T. Hollerer, and D. Stalling, **Volume Rendering: Mathematical Models and Algorithmic aspects**
An online version can be found at <http://www.cs.ucsb.edu/~holl/publications.html>
Defines the basic quantities involved in volumetric rendering and derives the volumetric and surface rendering equations.
- T. Farrell, M. Patterson, and B. Wilson, **A Diffusion Theory Model of Spatially Resolved, Steady-state Diffuse Reflectance for the Noninvasive Determination of Tissue Optical Properties *in vivo***, Med. Phys. 19(4), Jul/Aug 1992
Describes an application of the diffusion theory to the simulation of sub-surface scattering; derives the base formulas for the dipole approximation used by Jensen et al. (see below).
- H. Jensen, S. Marschner, M. Levoy, and P. Hanrahan, **A Practical Model for Subsurface Light Transport**, SIGGRAPH'01: Computer Graphics Proceedings, pp. 511-518
An online version of this paper can be found at <http://www-graphics.stanford.edu/papers/bssrdf/>
Introduces the concept of BSSRDF and describes a practical method for calculating sub-surface scattering based on the dipole approximation derived by Farrell et al. (see above).
- H. Jensen and J. Buhler, **A Rapid Hierarchical Rendering Technique for Translucent Materials**, SIGGRAPH'02: Computer Graphics Proceedings, pp. 576-581
An online version of this paper can be found at http://graphics.ucsd.edu/~henrik/papers/fast_bssrdf/
Introduces the idea of decoupling the calculations of surface illumination and the sub-surface scattering effect in a two-pass method; describes a fast hierarchical approach for evaluating subsurface scattering and proposes a reparametrization of the BSSRDF parameters for easier user adjustment.
- C. Donner and H. Jensen, **Light Diffusion in Multi-Layered Translucent Materials**, SIGGRAPH'05: ACM SIGGRAPH 2005 Papers, pp. 1032-1039
An online version of this paper can be found at <http://graphics.ucsd.edu/~henrik/papers/layered/layered.pdf>
Provides a concise description of the original BSSRDF solution method presented by Jensen et al; extends the model to multi-layered materials and thin slabs using multipole approximation.