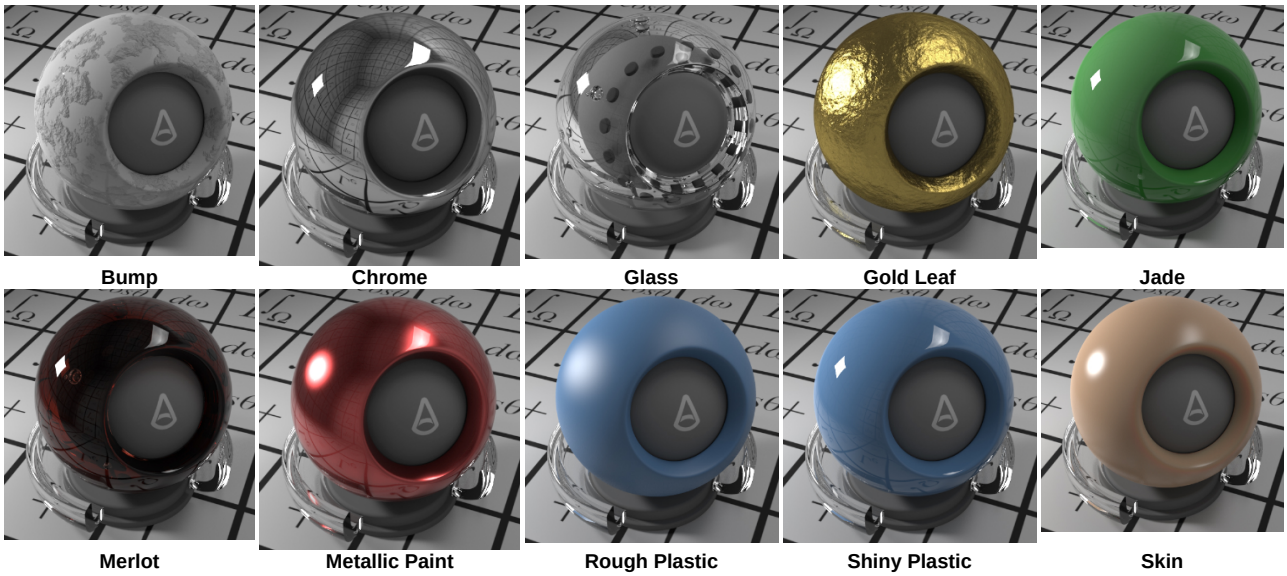
alSurface

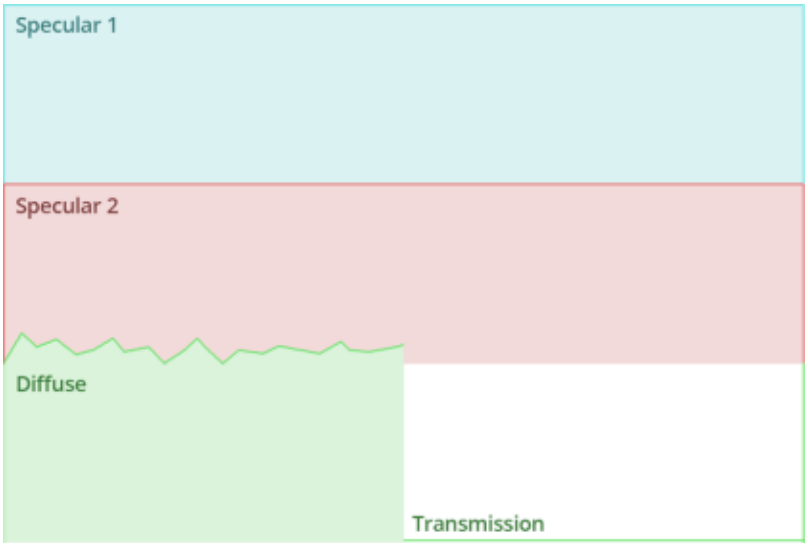
synopsis



Click on a thumbnail to download the shader

alSurface is a general-purpose, physically plausible surface shader. It supports diffuse, emission, sub-surface scattering, two layers of (glossy) specular and (glossy) transmission including single scattering. Other features include per-light AOV support.

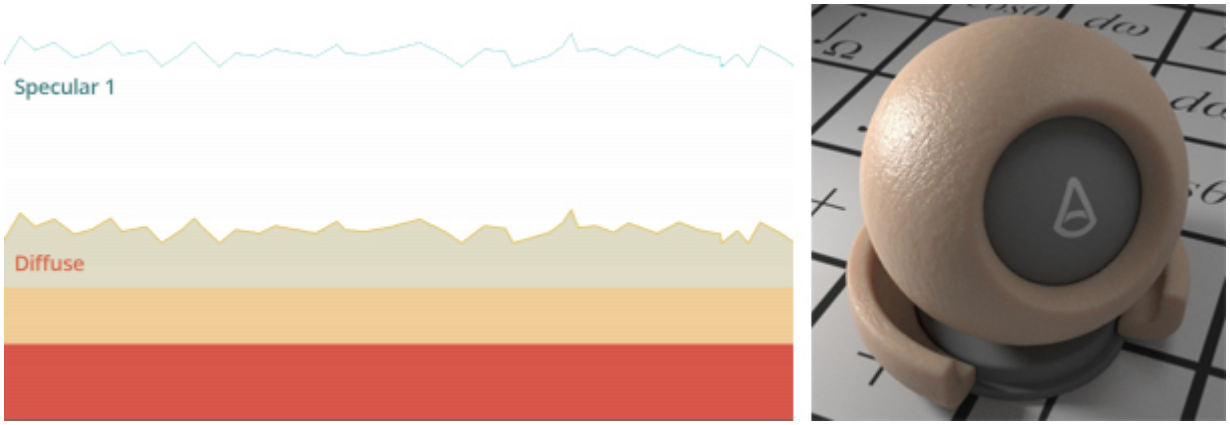
alSurface Layered Model



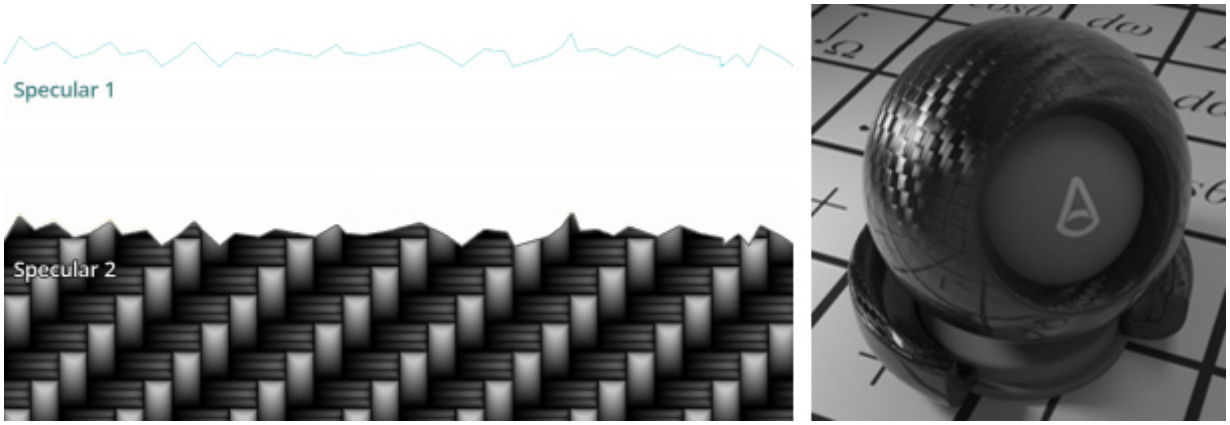
The structure of alSurface is is as follows:

- Conceptually it represents a material as a series of layers with a definite order.
- Either a diffuse or transmissive base, with one or two specular layers on top.
- Out of the box, this allows you to create 90% of the materials you will ever need.

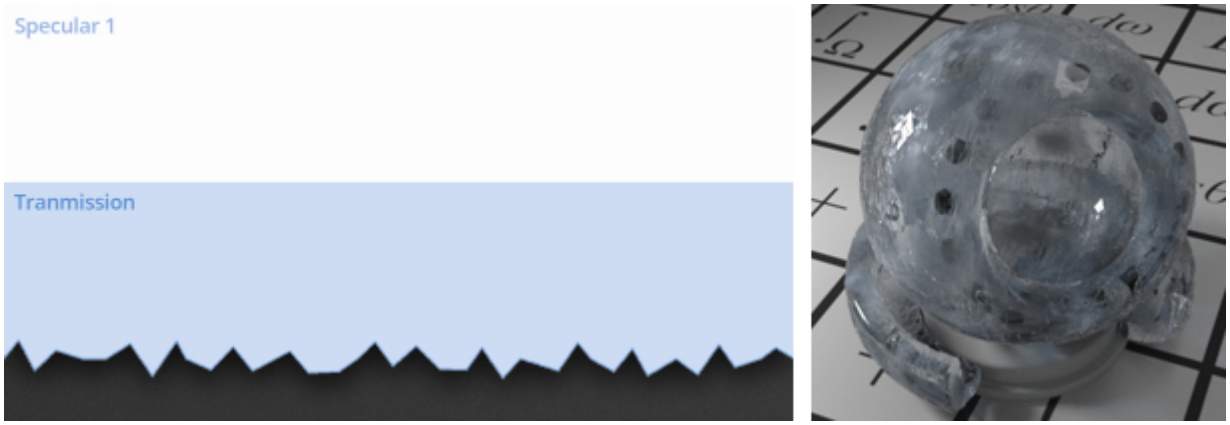
- Because layering is explicitly controlled, we can make it very efcient and ensure energy conservation.



Skin is a diffuse (subsurface scattering) base with a rough specular on top

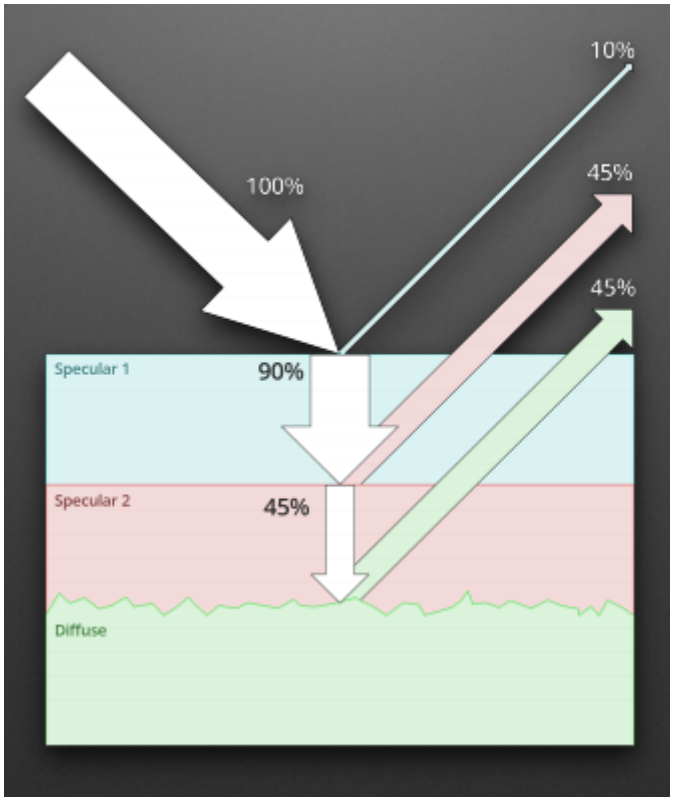


This carbon fiber material is a textured anisotropic layer with a clear-coat layer on top



This ice material is a transmissive, single-scattering base layer with a smooth specular layer on top

Layer Energy Conservation



The energy conservation model is simple and easy to understand.

- Each layer is an infinitely thin, microfacet scattering interface, which can either reflect or transmit light according to the Fresnel function. Any light that's not reflected or absorbed – according to the Fresnel function - is assumed to be transmitted.
- So we just evaluate each layer in a top-down order, integrating the Fresnel transmission as we go.
- At the same time, each layer then gets the chance to reflect a portion of the total transmitted light.
- So the amount of light reaching each layer is solely dependent on the index of refraction (IOR) of the layers above it.
- What's also important is that you can't turn this of: the user only has IOR controls for the layers and that's it. This means that the shader will always conserve energy and users don't have to worry about whether they're setting something right or not.

When used correctly this shader is energy conserving and correctly handles fresnel per microfacet.

The images below show the effect of this on a basic skin shader. Note how the alSurface render on the left does not display the dark edges and artificially bright rim highlights in the Standard shader render on the right (render times for both images are roughly equal).

Simple skin shader rendered with correct fresnel handling in alSurface

The same scene using Ai Standard showing edge-darkening artefacts

Ray Types

Unlike the Standard shader, alSurface uses glossy rays for both its specular lobes. This means that the reflection samples setting in the Render Settings window has no effect on the shader, and that the specular lobes will not respond to the sky shader (you should use the skydome light instead). It also means that light sources are always visible in both specular reflection layers.Shader AttributesDiffuse and Specular 1 will be your main port of call for most shaders. The shader attempts to conserve energy by attenuating the diffuse reflection according to the fresnel transmission of the Specular 1 and Specular 2 lobes. The shader also attenuates the Transmission component by the diffuse albedo (i.e. diffuseStrength * diffuseColor) in order to conserve energy.

The Specular 2 lobe goes "in between" Diffuse and Specular 1 and is useful for creating surfaces like car paint that have a clear varnish coat on top of a glossy base (Specular 1 would be the clear coat and Specular 2 would be the glossy base in this example).The Backlight lobe is simply a reverse-diffuse lobe similar to the standard shader and is useful for doing transmissive effects through thin surfaces. Unlike the standard shader, its result is not multiplied with the diffuse color parameter.

Due to the large number of controls, the alSurface shader is split up into several groups. The individual settings for each group are described in more detail below.

aiSkin vs alSurface

The main difference between the Skin shader and the alSurface shader is that alSurface's Scattering Colour is normalized, whereas the Skin's shader is not. This is important if, for example, you want to texture the result or blend it with Diffuse and don't want the Scatter Colour tinting your result. If you simply set your Diffuse colour to be blue you should get a similar result.

Light Groups

alSurface allows you to write the lighting contribution (including both direct and indirect illumination) of different lights in your scene to up to 8 separate AOVs (light_group1...8). In order to do this you need to attach an integer parameter called "lightGroup" to your lights to tell alSurface what group they are in.

In MtoA this is done by adding an int attribute called "mtoa_constant_lightGroup" to the **shape node** of your light and giving it a value from 1

to 8. Values outside of this range will be ignored (as will lights that do not have a lightGroup parameter).

The resulting AOVs will contain the sum of all the lights with the corresponding light group. Note that sub-surface scattering does not work with light groups. This is because the scattered light has no way of communicating which source it came from to the shader.

If you would like to just output the direct lighting contribution of the light groups, uncheck the "Indirect light groups" parameter in the "Advanced" section at the bottom of the shader.

The four smaller images below add up to make the larger image, which is exactly the same as the beauty

diffuse_strength

Scalar multiplier on the diffuse reflectance.

0 **0.5** **1**

diffuse_color

Color of the diffuse reflection.

Red **Green** **Blue**

diffuse_roughness

Oren-Nayar roughness control. Higher values make the surface more retro-reflective, giving a flatter, rougher appearance.

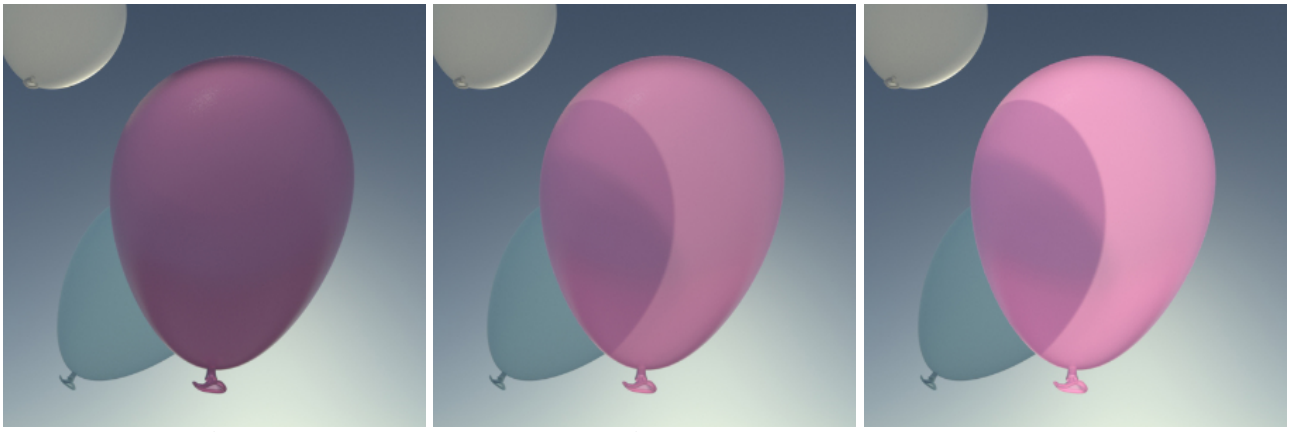
0 **0.5** **1**

backlight_strength

Scalar multiplier on the backlight transmittance.

0 **0.5** **1**

This attribute is more suited to thin translucent objects such as leaves and paper, or as in the example below, a balloon:

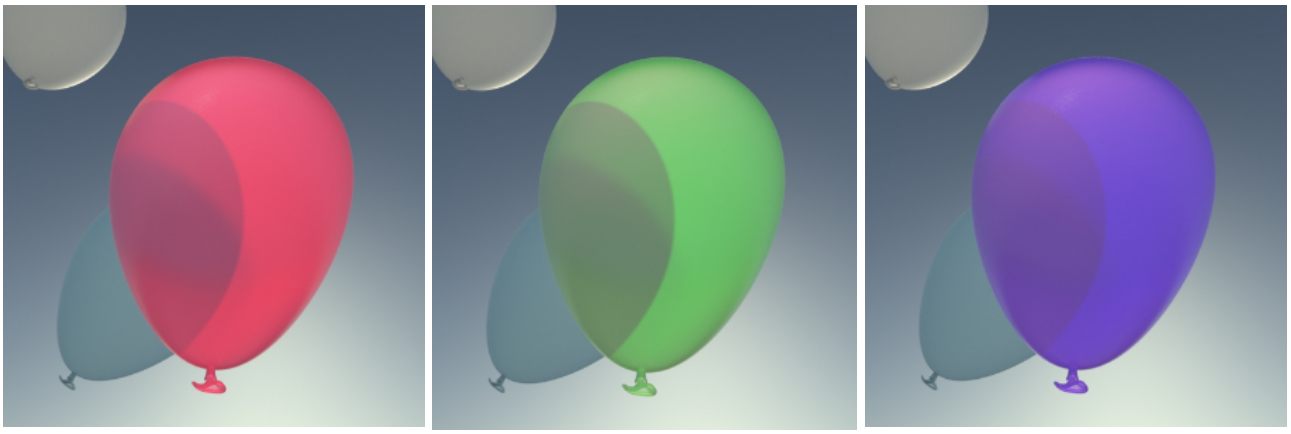


0 **0.5** **1**

backlight_color

Color of the backlight transmission.

Red **Green** **Blue**



Red **Green** **Blue**

backlight_indirect_strength

The amount of diffuse backlight received from indirect sources only.

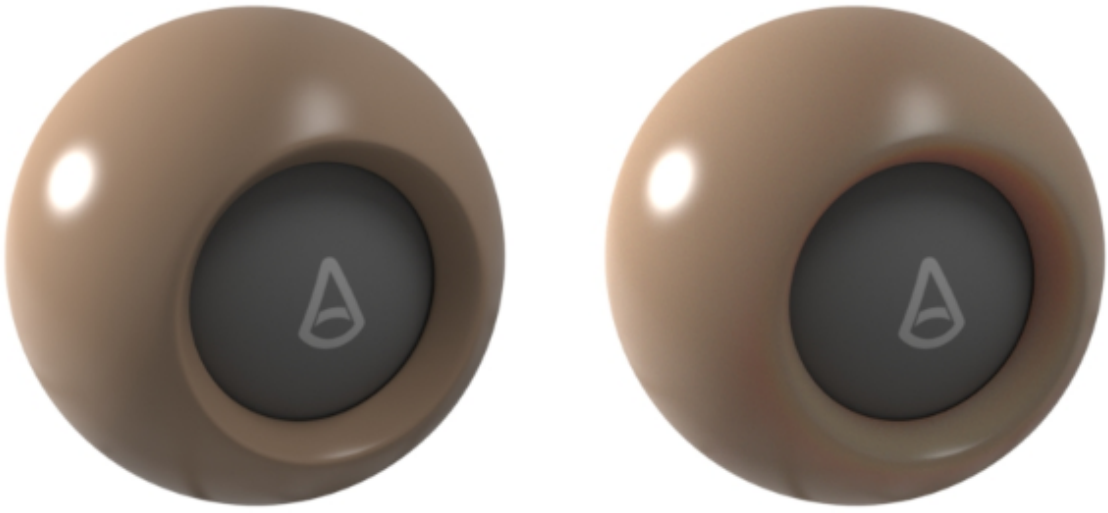
0 **0.5** **1**

sub-surface_scattering

Diffusion sub-surface scattering using Arnold's raytracing or pointcloud-based functions.

sss_mix

Blends the diffusion in with the Diffuse result. A value of 0 means no sub-surface scattering, a value of 1 means no Diffuse.



0 **1**

The images below show the difference between a SSS Mix of 0 and 1.

0 (Density Scale 1)

1 (Density Scale 1)

sss_distance

How far the light travels through the surface. Higher values will smooth the appearance of the sub-surface scattering. Results will vary depending on the scale of the object in your scene. Arnold will take into account the shape and thickness of the object being lit. If it is thin enough, the object will often see light scattering out the back side, depending on the distance value.

0

3

sss_weight

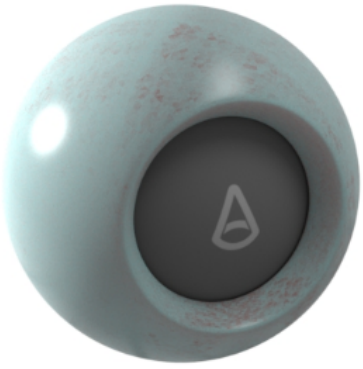
These values control the relative weights of the three SSS layers. The weights for each layer are summed and normalized, so if you have the other weights set to 0 then setting the first one to anything non-zero will have no effect.

0

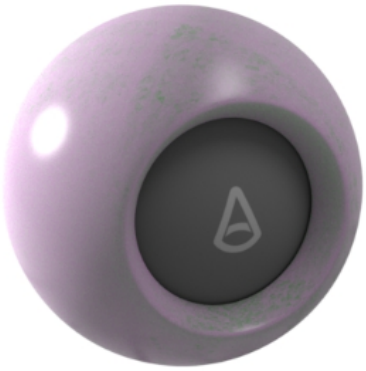
1

sss_color

The color the light tends to as it travels through the surface.



Red



Green

Blue

The following images show the effect of changing the SSS Color 3 attribute:

Red

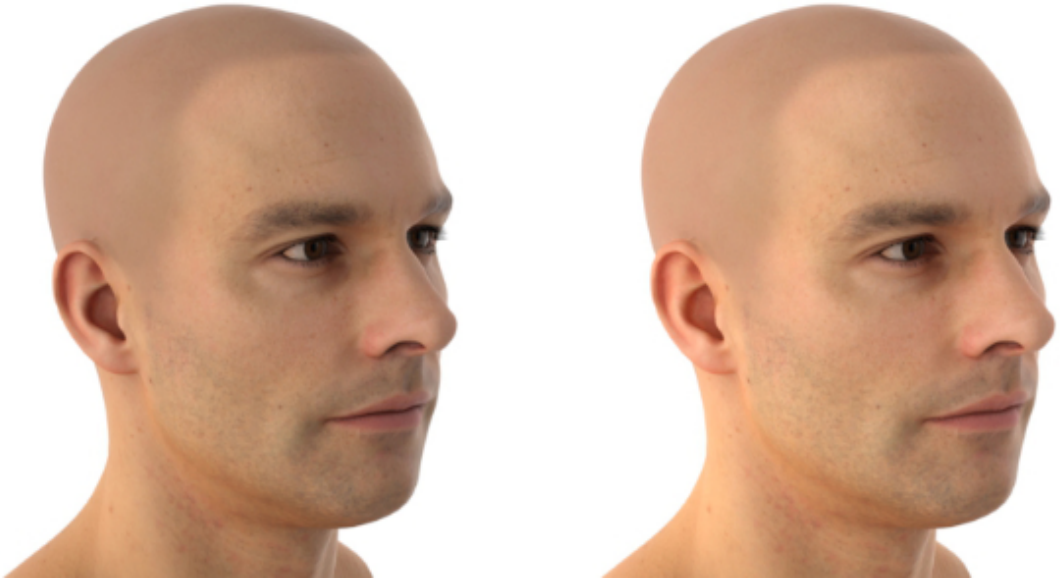
Green

Blue

sss_density_scale

A multiplier on the units of scattering. Higher values give a denser appearance to the material.

0.1 **0.5** **1**



0 **1**

sss_extra_samples

Allows you to modify the sampling rate of the lobe from the value specified in the globals. Positive numbers increase the sampling rate, negative numbers decrease it.

sss_enable_caustics

Turning this on allows caustic paths--light that is transmitted or reflected from a specular surface before being diffusely reflected from the current surface--to contribute to the image. With caustics enabled resulting renders will be extremely noisy.

sss_enable_caustics

Turning this on allows caustic paths--light that is transmitted or reflected from a specular surface before being diffusely reflected from the current surface--to contribute to the image. With caustics enabled resulting renders will be extremely noisy.

indirect_strength

Color of the indirect diffuse reflection.

0

0.5

1

specular_strength

Scalar multiplier on the reflectance of the top specular lobe.

0.1

0

1

Specular 1 Strength: 1. Specular 2 Strength: 0

Specular 1 Strength: 1. Specular 2 Strength: 1 (Roughness 0.6, Specular Color: Red)

specular_color

Color of the top specular lobe.

Red

Green

Blue

specular_roughness

Roughness of the top specular lobe.

0 **0.5** **1**

anisotropy

Anisotropy reflects and transmits light with a directional bias and causes materials to appear rougher or glossier in certain directions. The default value for Anisotropy is 0.5, which means 'isotropic'. As you move this control towards 0.0, the surface is made more anisotropic in the U axis, and as you move the control towards 1.0 the surface is made more anisotropic in the the V axis.

0 (Roughness 1) **0.5 (Roughness 1)** **1 (Roughness 1)**

rotation

The rotation value changes the orientation of the anisotropic reflectance in UV space. At 0.0, there is no rotation, while at 1.0 the effect is rotated by 180 degrees. For a surface of brushed metal, this controls the angle at which the material was brushed. For metallic surfaces, the anisotropic highlight should stretch out in a direction perpendicular to the brushing direction.

0.25 **0.5** **0.75**

specular_ior

Index of refraction of the top specular lobe. Common values are ~1.34 for water, ~1.5 for common plastics, 1.5-1.8 for glass. Although not correct, values in the range 10-100 can give a reasonable approximation of metals.

1 **2.5** **10**

Specular IOR 1 **Specular IOR 2.5** **Specular IOR 5**

specular_roughness_depth_scale

Each successive specular bounce has its roughness multiplied by this number, effectively making surfaces deep in the ray tree appear less shiny. In some situations this can help reduce noise.

specular_extra_samples

Allows you to modify the sampling rate of the lobe from the value specified in the globals. Positive numbers increase the sampling rate, negative numbers decrease it.

specular_normal

Plugging in a vector here will use it in place of the shader globals normal. This can be useful for adding a smooth coat over a bumpy diffuse layer, or adding a wet layer.

specular_indirect_strength

The amount of specularity received from indirect sources only. Values other than 1.0 will cause the materials to not preserve energy and global illumination may not converge.

0

1

specular_indirect_clamp

This control will clamp pixel samples only within the indirect specular. This can be useful in scenes that contain 'spike noise' or 'fireflies'.

transmission_synopsis

No Transmission

Transmission

Transmission takes into account light that reaches the surface of the object and also calculates anything that might exist below the surface. Therefore it is possible to achieve an effect where geometry is visible inside of an object, such as bones inside a translucent hand.

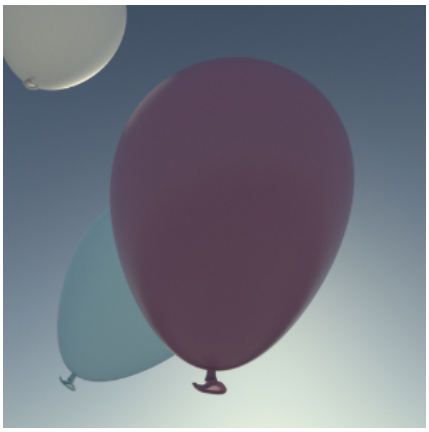
transmission_strength

Scalar multiplier on the transmission.

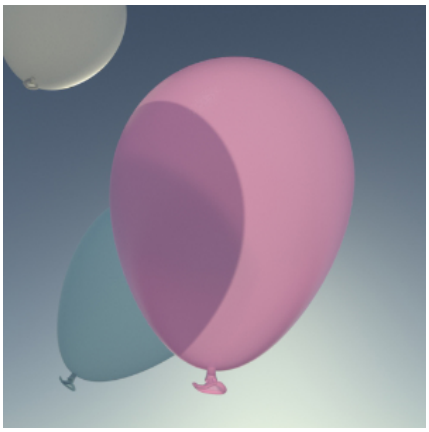
0

0.5

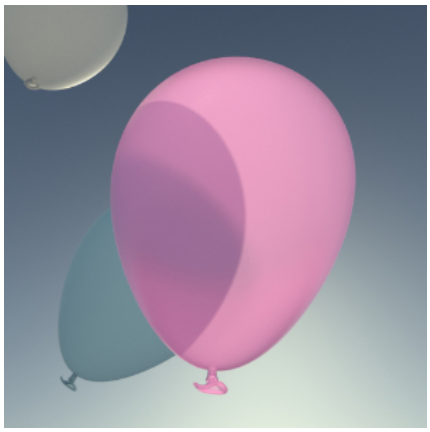
1



0



0.5



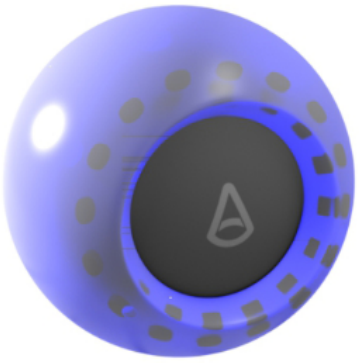
1

transmission_color

Color multiplier on the transmission.

Red

Green



Blue

Sea Transmission Color: White

Blue

link_to_specular_1

When this is enabled, the transmission lobe will match its roughness and IOR to the values of the Specular 1 lobe. This is essential for realism in any kind of transparent material; there should rarely be a reason for you to disable this and override the values.

Disabled

Enabled

transmission_roughness

Roughness of transmission. Higher values give a frosted glass appearance. You must disable the **'Link to Specular 1'** checkbox for this to have any effect.

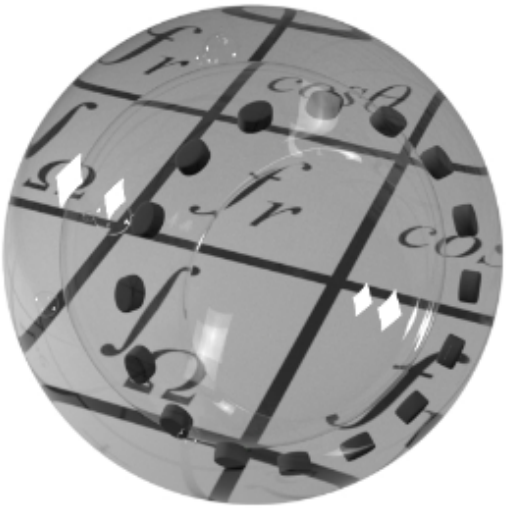
0

0.5

1

transmission_ior

Index of refraction for the transmission lobe. This affects both the fresnel transmission and the amount of bending of the light as it passes through the surface. You must disable the **'Link to Specular 1'** checkbox for this to have any effect.



1

1.5 (glass)

Specular 1 IOR: 1 to 5

Specular 2 IOR: 1 to 5

Click on images to view animations

Scattering

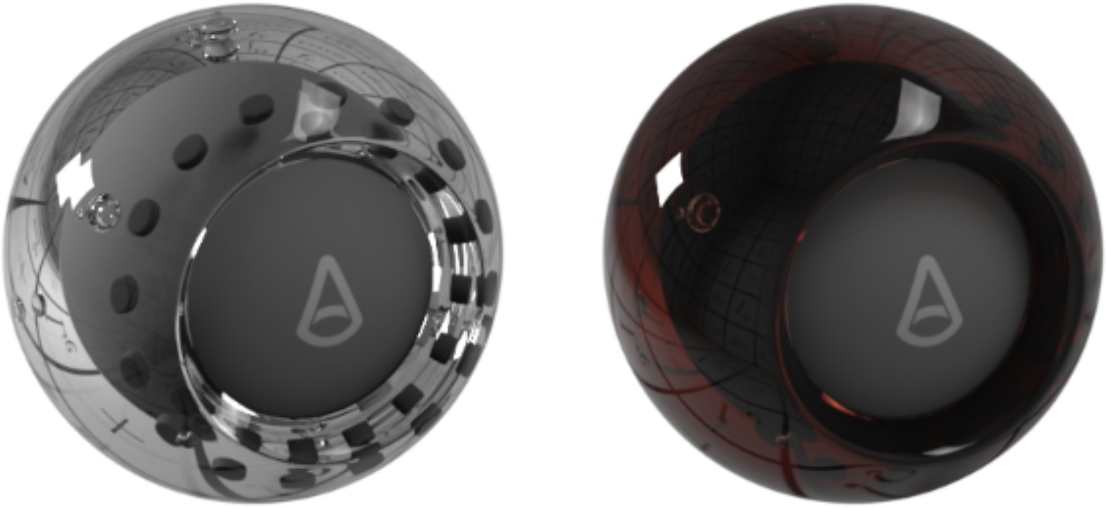
scattering_strength

Scalar multiplier on the single scattering result.

0 **0.5** **1**

scattering_color

The color that the scattered light will tend to as it travels through the medium. Use this attribute to create a 'tinted' glass effect.



White **Merlot**

scattering_direction

Phase function control. Positive numbers give forward scattering, negative numbers back-scattering.

0 (Density Scale 1)

1 (Density Scale 1)

scattering_balance

Balance between absorption and scattering. Lower values will give a more 'clear' result (favouring absorption), while higher values will give a more 'cloudy' result (favouring scattering).

scattering_in-scattering

When this is enabled, single in-scattering will be calculated for each transmission ray. This can be expensive. If your material has a low balance value (low scattering coefficient) you may want to disable this for faster renders.

scattering_density_scale

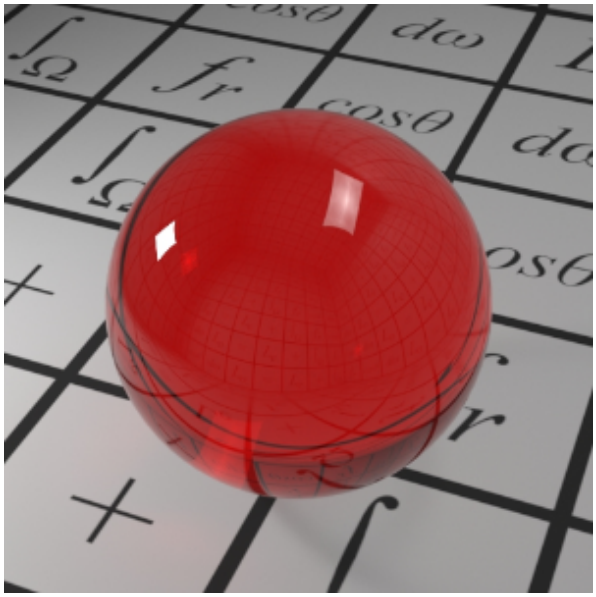
Multiplier on the scale of the scattering. Higher values give the appearance of a denser medium.

0.1

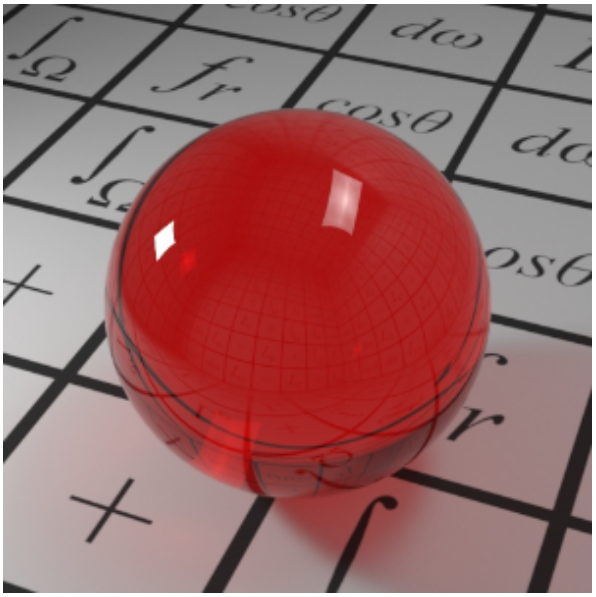
0.5

1

Note how the tinted color of the shadow changes according to the Density Scale value:



Density Scale 0



Density Scale 1

scattering_specify_coefficients

When this is enabled the Balance and Color parameters are ignored and you can specify the scattering and absorption coefficients directly. This is useful if you have measured data you would like to use.

scattering_scattering

The scattering coefficient.

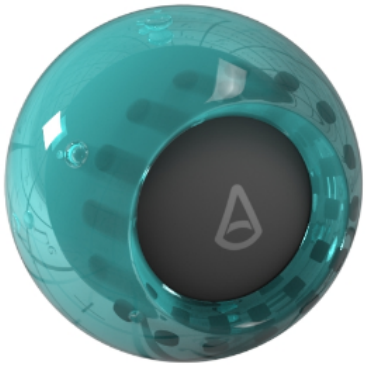
Red

Green

Blue

scattering_absorption

The absorption coefficient.



Red

Green

Blue

Transmission Advanced

transmission_roughness_depth_scale

Each successive transmission has its roughness multiplied by this number, effectively making surfaces deep in the ray tree appear shinier. In some situations this can help reduce noise.

transmission_extra_samples

Allows you to modify the sampling rate of the lobe from the value specified in the globals. Positive numbers increase the sampling rate, negative numbers decrease it.

transmission_enabled_internal_reflections

Turning this off disables specular reflection paths before this transmission. This is similar to the Enable caustics parameter in the Diffuse section. You will want to disable this if your Roughness goes above ~0.3. You will also want to turn this off for highly scattering materials such as wine, water etc to save on render time.

transmission_rr

...

transmission_rr_depth

...

transmission_indirect_clamp

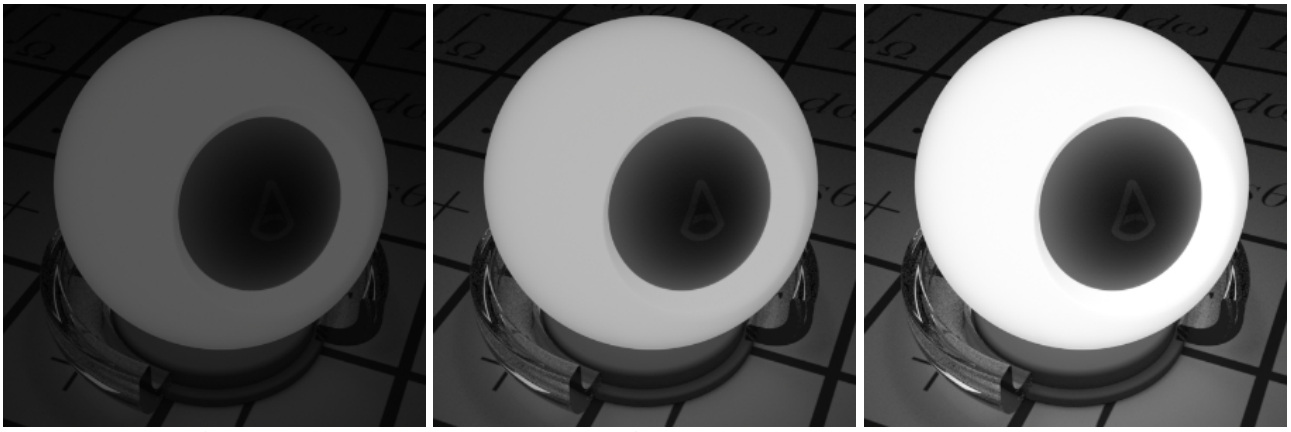
...

emission

Simulates light being emitted from the surface.

emission_strength

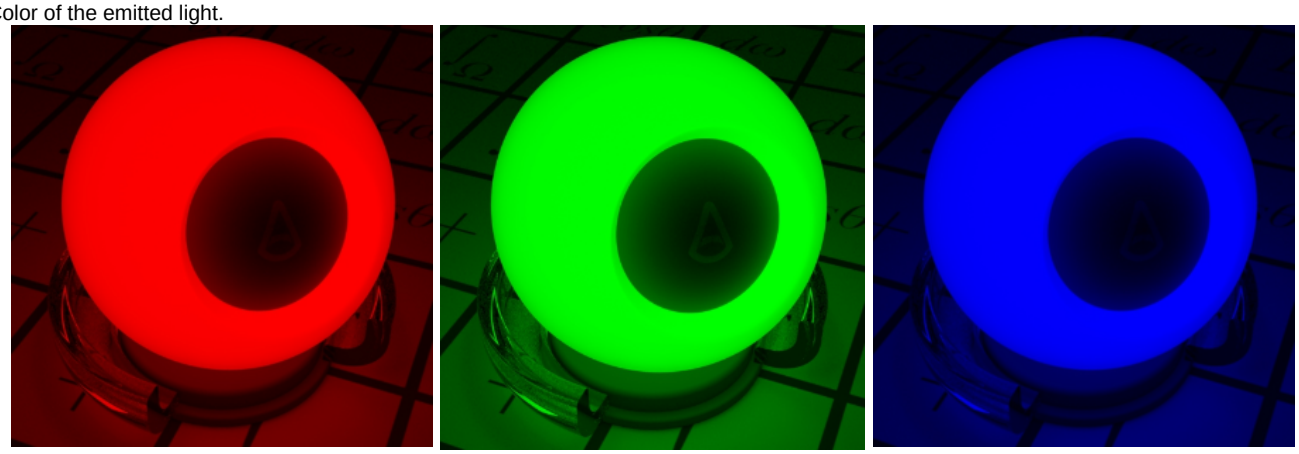
Scalar multiplier on the amount of emitted light.



0.1 **0.5** **1**

emission_color

Color of the emitted light.



Red **Green** **Blue**

ids

Plugging something into any of these inputs will result in it being directly written out to the corresponding id_X output (as listed below). This is useful for generating mattes for comp or outputting parts of the shading tree for comp or for debugging purposes.

aovs

Options for controlling how the shader outputs AOVs.

indirect_light_groups

Enable the indirect light groups feature. When this is enabled, all the bounces for each light group will be written out, as opposed to just the direct lighting. The cost of this is an increase in render time of roughly 1% on a reasonable shader network.

write_standard_aovs

When this is enabled, the shader will only write out AOVs that match the AOVs of the standard shader. In order to do this it will sum some AOVs together, notably: diffuse=diffuse+backlight, specular=specular1+specular2, refraction=refraction+single_scatter

In this section there is also a string field for every AOV that allows you to override the name of the output to which it writes:

- diffuse_color

- direct_diffuse
- direct_diffuse_raw
- indirect_diffuse
- indirect_diffuse_raw
- direct_specular
- indirect_specular
- direct_specular_2
- indirect_specular_2
- single_scatter
- sss
- refraction
- emission
- uv
- depth
- light_group_1
- light_group_2
- light_group_3
- light_group_4
- light_group_5
- light_group_6
- light_group_7
- light_group_8
- id_1
- id_2
- id_3
- id_4
- id_5
- id_6
- id_7
- id_8

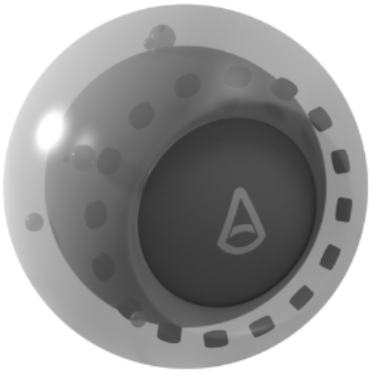
bump_mapping

Connection for a bump node.

opacity

Controls the degree to which light is not allowed to travel through it. Unlike transparency, whereby the material still considers diffuse, specular etc, opacity will affect the entire shader. Useful for retaining the shadow definition of an object, whilst making the object itself invisible to the camera. Use this attribute to cutout textures such as a leaf mask.

1 (white)



0.5 (mid-grey)

0 (black)

You must ensure that 'Opaque' is disabled for the mesh that the Standard shader is assigned to when using 'Opacity'.

Opaque: On

Opaque: Off