Specular Reflections

![Specular Reflections panel](image)

**General**

**Weight**

The *specular_weight* Influences the brightness of the specular highlight.

![Specular Weight](image)

- 0
- 0.5
- 1 (default)

**Color**

The color the specular reflection will be modulated with. Use this color to 'tint' the specular highlight. You should only use colored specular for certain metals, whereas non-metallic surfaces usually have a monochromatic specular color. Non-metallic surfaces normally do not have a colored specular.
Roughness

Controls the glossiness of the specular reflections. The lower the value, the sharper the reflection. In the limit, a value of 0 will give you a perfectly sharp mirror reflection, while 1.0 will create reflections that are close to a diffuse reflection. You should connect a map here to get variation in the specular highlight.

The 'microscopic' features of a surface affect the diffusion and reflection of light. This 'micro surface' detail has the most noticeable effect on specular reflections. In the diagram below, you can view parallel lines of incoming light commence to diverge when reflected from rougher surfaces when each ray hits a part of the surface with a different orientation. In summary, the rougher the surface becomes, the more the reflected light will diverge or appear 'blurred.'
'Microsurface' detail represented as a general measure of roughness (this surface would have a high specular_roughness value).

The brightness of the specular highlight is automatically linked to its size due to the standard_surface shader's energy-conserving nature. In the example below, all of the materials are reflecting the same amount of light, but the rougher surface is spreading it out in multiple directions. However, with low amounts of roughness, the surface is reflecting a more concentrated amount of light.

To get variation in the highlights of the surface, a map should be connected to the Specular Roughness. This will influence not only the brightness of the highlight but also its size and the sharpness of the environmental reflection.

You can connect the file texture to a range shader to control the effect of the specular_roughness.
The `specular_roughness` affects both specular reflection and refraction. There is also a `transmission_extra_roughness` parameter to add some additional roughness for refraction if required. You can, however, use `coat` to create a rough reflection layer over a sharp refraction.

**Advanced**

**Metalness**

With metalness 1.0 the surface behaves like a metal, using fully specular reflection and complex fresnel.
The metal appearance is controlled using the `base_color` (facing) and `specular_color` (edge tint) parameters. These are automatically translated to physical and values, to achieve the same look but with easily tweakable and texturable colors. Some examples of real-world values for metals can be found below.

<table>
<thead>
<tr>
<th></th>
<th>Base Color</th>
<th>Specular Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium (Al)</td>
<td>0.912 0.914 0.920</td>
<td>0.970 0.979 0.988</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>0.926 0.721 0.504</td>
<td>0.996 0.957 0.823</td>
</tr>
</tbody>
</table>

For a perfectly sharp and mirror-like reflection, increase `metalness` to 1 and reduce `specular_roughness` to 0. The `base_weight` should also be set to 1.

When `metalness` is enabled, the `specular_weight` and `specular_color` only control the edge tint, while the `base` is still affected by roughness.
<table>
<thead>
<tr>
<th>Element</th>
<th>Color 1</th>
<th>Color 2</th>
<th>Color 3</th>
<th>Color 4</th>
<th>Color 5</th>
<th>Color 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold (Au)</td>
<td>0.944</td>
<td>0.776</td>
<td>0.373</td>
<td>0.998</td>
<td>0.981</td>
<td>0.751</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>0.531</td>
<td>0.512</td>
<td>0.496</td>
<td>0.571</td>
<td>0.540</td>
<td>0.586</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>0.632</td>
<td>0.626</td>
<td>0.641</td>
<td>0.803</td>
<td>0.808</td>
<td>0.862</td>
</tr>
<tr>
<td>Mercury (Hg)</td>
<td>0.781</td>
<td>0.779</td>
<td>0.779</td>
<td>0.879</td>
<td>0.910</td>
<td>0.941</td>
</tr>
<tr>
<td>Nickel (Ni)</td>
<td>0.649</td>
<td>0.610</td>
<td>0.541</td>
<td>0.797</td>
<td>0.801</td>
<td>0.789</td>
</tr>
<tr>
<td>Platinum (Pt)</td>
<td>0.679</td>
<td>0.642</td>
<td>0.588</td>
<td>0.785</td>
<td>0.789</td>
<td>0.784</td>
</tr>
<tr>
<td>Metal</td>
<td>Aluminium</td>
<td>Copper</td>
<td>Gold</td>
<td>Iron</td>
<td>Lead</td>
<td>Mercury</td>
</tr>
<tr>
<td>-----------</td>
<td>-----------</td>
<td>--------</td>
<td>--------</td>
<td>----------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>Silver (Ag)</td>
<td>0.962 0.949 0.922</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.999 0.998 0.998</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nickel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Platinum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silver</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Metalness values between 0.0 and 1.0 can be used to texture surfaces like rusted iron, where different areas of the surface can have more reflective clean metal and more diffuse rust. PBR metalness maps from applications like Substance Painter can be connected to this parameter.

![Rusted iron texture](image1)

Rusted iron texture -> metalness

![Greasy worn metal](image2)
![Worn painted cement](image3)
![Rock infused with copper](image4)

Shaders using metalness textures

IOR

The IOR parameter (Index of Refraction) defines the material's Fresnel reflectivity and is by default the angular function used. Effectively the IOR will define the balance between reflections on surfaces facing the viewer and on surface edges. You can see the reflection intensity remains unchanged, but the reflection
intensity on the front side changes a lot.

Using a very high IOR value can look quite similar to metalness. It looks the same if you set the base_color to the specular_color and the specular_color to black. The difference is that you get an extra reflection at the edges, with the specular_color controlling the edge tint. The metal fresnel works the same as in the new complex IOR shader, with the artistic parameters.

You should normally use IOR for materials like plastic, glass, or skin (dielectric fresnel) and metalness for metals (conductive fresnel with complex_IOR). The other reason is that metalness is easier to texture since it's in the 0..1 range, and using textures from applications like Substance painter works best when using metalness rather than IOR.

Specular IOR with Transmission

The default value of 1.0 is the refractive index of a vacuum, i.e., an object with IOR of 1.0 in empty space will not refract any rays. In simple terms, 1.0 means ‘no refraction’. The standard_surface shader assumes that any geometry has outward-facing normals, that objects are embedded in the air (IOR 1.0) and that there are no overlapping surfaces.

Normals

When rendering refractive surfaces, it is very important that the normals of the geometry face in the
right direction. In the example below (left), you can see the difference between normals that are facing in the right direction (outward), versus those that are facing inwards (incorrect). This is especially important when rendering surfaces with double-sided thickness, such as glass. However, with air bubbles in glass (below center), the reverse is true. The bubble geometry normals should be reversed and the bubbles should be combined with the glass geometry. Normal direction is equally important when rendering single-sided surfaces such as a car windscreen (right).

If you see any black where there should be refraction, you may not have a high enough \textit{transmission\_ray\_depth} value (found in the \textit{ray\_depth} section in the render settings). The default value is eight, which is sufficient for most cases.

**Options**

**Internal Reflections**

Unchecking internal reflections will disable indirect specular and mirror perfect reflection computations when ray refraction depth is bigger than zero (when there has been at least one refraction ray traced in the current ray tree).
In the right image below, the sphere appears black because *internal_reflections* is disabled in the *standard_surface* shader assigned to the sphere.

**Indirect Specular**

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.
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 \textit{anisotropy} is 0, which means 'isotropic.' As you move the control towards 1.0, the surface is made more anisotropic in the U axis.

Anisotropy is suitable for materials that have a clear brush direction such as brushed metal which has tiny grooves in which form a 'stretched' anisotropic reflection.
Anisotropic reflections are suitable for brushed metal effects such as in the example below:

You may notice faceting appears in highlights when using Anisotropy. It is possible to remove the faceted appearance by enabling smooth subdivision tangents (via Arnold subdiv_smooth_derivs parameter). Take into account this requires a subdivision iteration of at least one in the polymesh to work.
Faceting seen in the anisotropic highlight


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 with 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.
It is possible to assign textures to the rotation. When doing so, it is advisable to avoid texture filtering. This means disabling MIP-mapping and disabling the magnification filter, which by default is set to "smart bicubic." One way is to set the `mipmap_bias` of the image node to a strong negative value, like -8, which means "use 8 MIP levels higher resolution than usual".