

IRAY MATERIAL PLUGIN

FOR 3DS MAX 2016

Release version 1.5

Released: 10 July 2014

NVIDIA ARC

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1 DISCLAIMER

The iray material plugin presented in this document is provided freely. There is no agreement or guarantee between you and NVIDIA regarding your use or modification of this plugin. Support for this plugin may be terminated at the sole discretion of NVIDIA.

2 (RE)DISTRIBUTION

The package, as made available by NVIDIA on its web sites or elsewhere, may be redistributed if and only if it is done so in its entirety and without any modifications.

3 KNOWN ISSUES

Limitations:

- The material currently does not render with mental ray (future support is uncertain).

4 RELEASE NOTES

4.1 VERSION 1.5H

10 July 2014 (limited availability)

- Initial release for Max 2016
- Cleanup of outdated limitations and installation hints

4.2 VERSION 1.5

28 October 2013 (public availability)

- Ensure parameter names are unique and do not contain spaces, also make some names less confusing

4.3 VERSION 1.4

14 June 2013 (public availability)

- Initial release for Max 2015

4.4 VERSION 1.3

14 June 2013 (public availability)

- Material displayed bad colors in the viewport for newer/final versions of Max 2014
- Fixes to the `iray_layered_material_max.mi`

4.5 VERSION 1.2

24 July 2012 (public availability)

- First public release
- Fixed physical scaling of luminance parameter
- Added viewport representation of emission parameters
- Added mental ray shader stub to prevent missing shader error

4.6 VERSION 1.1

13 July 2012 (limited availability)

- Fixed issue where Active Shade would not see parameter changes until the next update
- Added “Reset to defaults” preset

4.7 VERSION 1.0

22 June 2012 (limited availability)

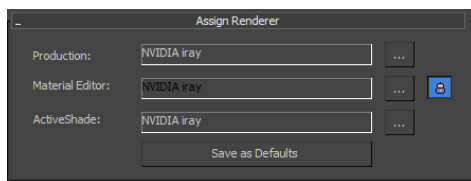
- First feature complete release

5 INSTALLATION

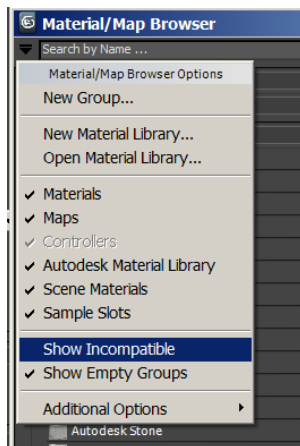
This plugin is compatible with 3ds Max 2016 and 3ds Max Design 2016. To install, you must copy files into the 3ds Max installation folder, which typically implies having administrator privileges. Simply drag and drop the “NVIDIA” and “plugins” folders included in the package into the install folder of 3ds Max (For example *C:\Program Files\Autodesk\3ds Max 2016* or *C:\Program Files\Autodesk\3ds Max Design 2016*) and restart 3ds Max if it was still running.

5.1 SETUP & USAGE

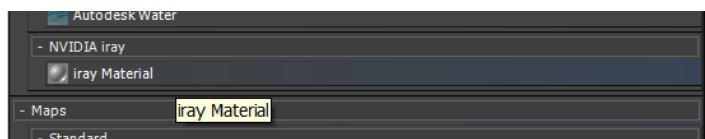
The iray material is **compatible with iray only**. To access it from the material browser, make sure that **NVIDIA iray** is the currently active renderer:



Or enable **Show Incompatible** in the material browser options:

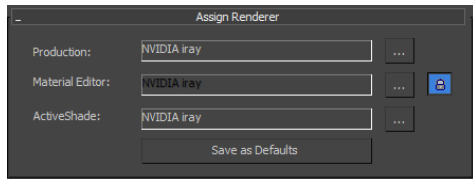


The “iray Material” is displayed in the material browser, under the category **NVIDIA iray**:



5.2 MATERIAL EDITOR PREVIEW

Because the iray Material only renders with iray, be sure to select iray as the material editor renderer:



The performance of material editor previews with iray can vary greatly. For example, subsurface scattering makes preview renders much slower. If this becomes an issue, you can switch the material editor renderer mental ray, however the previews will render black.

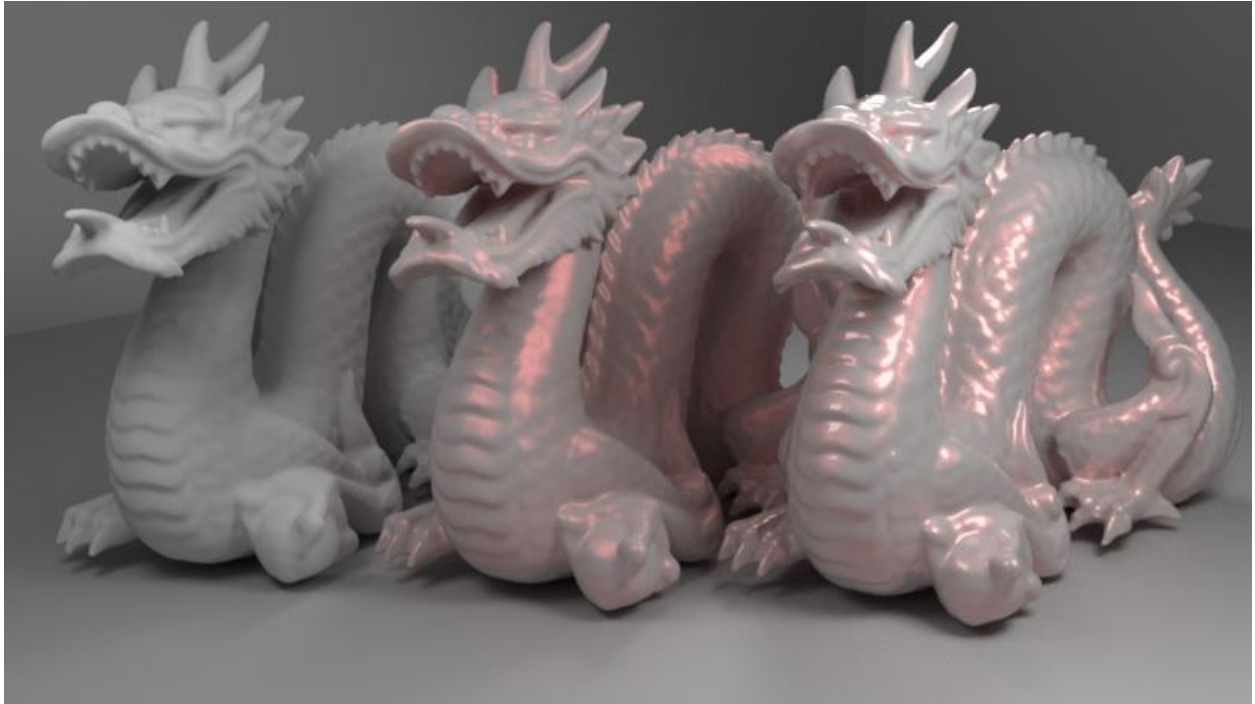
6 OVERVIEW

The material model used internally by iray is extremely flexible yet very complex. It functions through relatively simple bi-directional scattering distribution functions (BSDFs) which can be layered, blended, and mixed in a rather arbitrary manner. The iray material plugin for 3ds Max simplifies this model by exposing a limited set of combinations which should satisfy that vast majority of use cases.

The iray material plugin simplifies the iray internal material model to three layers:

- **Layer 1 (top): Reflective Coating**
This layer is useful for simulating clear coats, varnishes, or (uncolored) Fresnel reflections for materials such as plastic. Being the top-most layer, it takes precedence over the underlying ones.
- **Layer 2 (middle): Metallic Flakes**
A layer of procedural metallic flakes, useful for simulating car paint and other sparkling materials.
- **Layer 3 (bottom): Base Layer**
This layer mixes a diffuse and a glossy component. It is the core of the material; it offers most of the shading flexibility.

The layers are evaluated in the order outlined above; each layer has a weight which determines its opacity and the visibility of underlying layers.



Left: a grey diffuse base layer only

Center: a red metallic flakes layer is added

Right: a white reflective coating is added

Notice how the successive layers occlude the layer(s) below. For example, the metallic flakes become less visible after the clear coat is added.

7 TEMPLATES



Templates are pre-defined sets of material parameter values. These templates should not be interpreted as being *the* correct representation for these materials; they are meant to be used as starting points for material creation, as hints to how the material *can* be set up.

Warning: selecting a preset will override all of the current material settings.



Left: car paint preset

Center: anodized aluminum preset

Right: silk preset

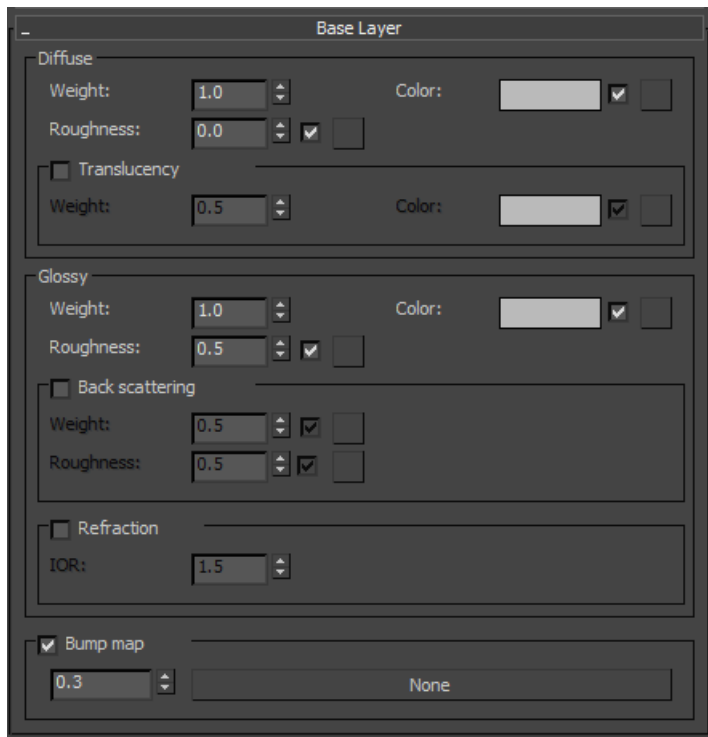
Note: Some presets are dependent on the unit setup and rely on the scene being modeled with appropriate scale. For example, the wax preset would not look right on a candle that is one kilometer wide.

8 BASE LAYER

This is the bottom layer which sits below the reflective coating and the metallic flakes. It implements a mix of:

- a diffuse BSDF (reflection + translucency)
- a glossy BSDF (reflection + refraction)

It also possesses a bump map.



8.1 DIFFUSE & GLOSSY WEIGHTS

The diffuse and glossy components are mixed using their respective weights. If the total of these weights exceeds 1.0, they are internally normalized. Thus, two values of 1.0 will yield the same result as two values of 0.5.



Left: diffuse component only

Center: 50% diffuse, 50% glossy (roughness = 0.5)

Right: glossy component only (roughness = 0.5)

8.1.1.1 DIFFUSE COMPONENT

The section exposes the parameters of the diffuse BSDF which controls the diffuse reflectivity of the base layer and, optionally, diffuse transmission (translucency).

When translucency is enabled, the translucency weight determines what portion of the diffuse component is allocated to transmission. A diffuse weight of 0.4 and a translucency weight of 0.25 result in 30% diffuse reflectivity and 10% translucency.



A 100% diffuse material (diffuse weight = 1.0, glossy weight = 0.0).

Left: translucency weight = 0.0

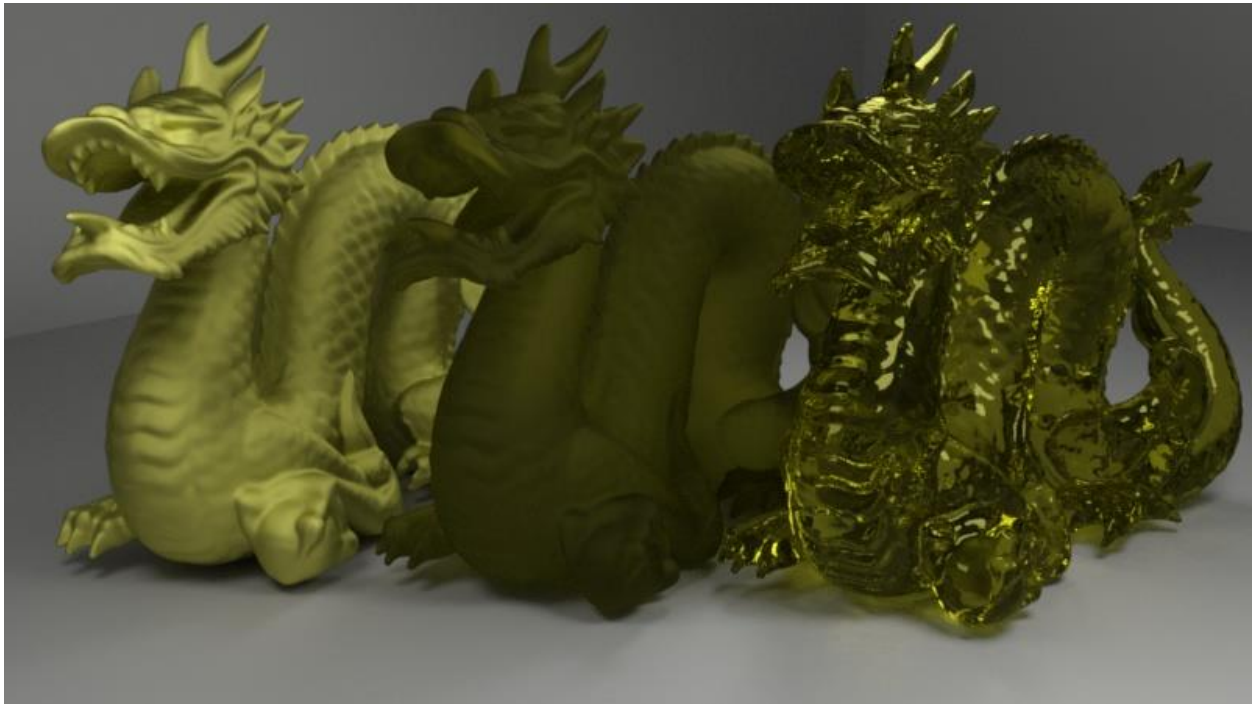
Center: translucency weight = 0.5

Right: translucency weight = 1.0

8.1.2 GLOSSY COMPONENT

The section exposes the parameters of the glossy BSDF which controls the glossy reflectivity of the base layer and, optionally, glossy refraction.

When refraction is enabled, the glossy BSDF becomes transparent and will transmit light following a physically-based Fresnel curve using the index of refraction (IOR). There is no weight to control the amount of glossy transmission; the glossy BSDF behaves in a strictly physical manner in order to ensure consistency of results and to avoid common problems which would negatively affect the realism of the image. For example, without a Fresnel curve, total internal reflection becomes ill-defined, making it impossible to produce a realistic image: energy loss (visible as black edges) and other artifacts would result.



A 100% glossy material (diffuse weight = 0.0, glossy weight = 1.0).

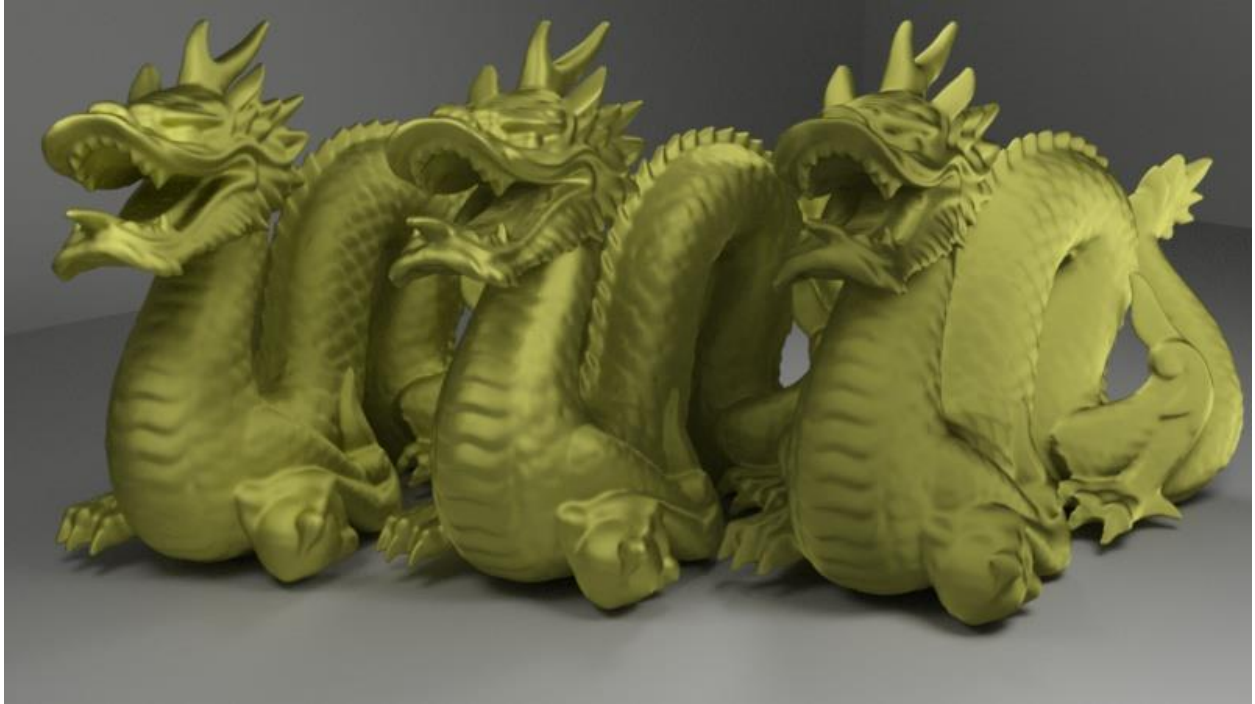
Left: refraction disabled (roughness = 0.5)

Center: refraction enabled (roughness = 0.5)

Right: refraction enabled (roughness = 0.0)

8.1.3 BACKSCATTERING

Backscattering is the property of certain materials to reflect light back towards the emitter, rather than following the standard reflection direction. For example, a mirror reflects forward whereas road signs reflect much of the light backwards. This effect plays an important role in the simulation of fabrics. When it is enabled, the backscattering weight controls how much of the glossy component is dedicated to backscattering.



A 100% glossy material (diffuse weight = 0.0, glossy weight = 1.0).

Left: backscatter weight = 0.0

Center: backscatter weight = 0.5

Right: backscatter weight = 1.0

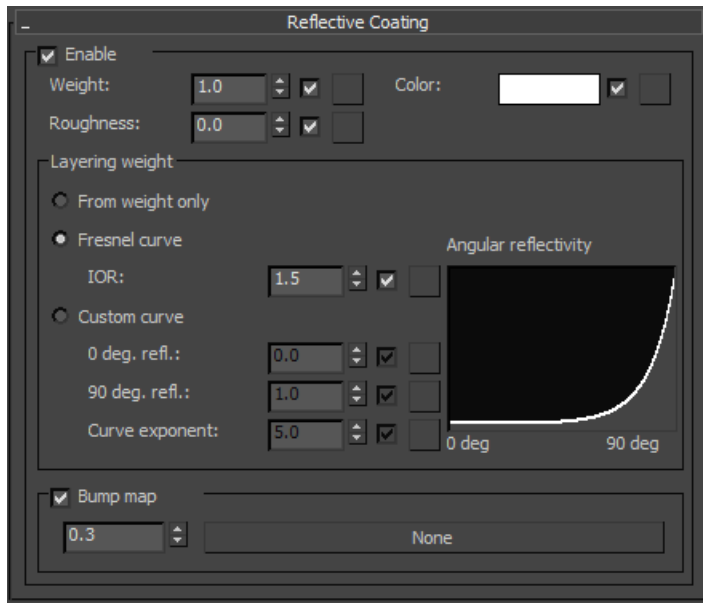
8.2 BUMP MAP

This bump map affects the base layer only.

9 REFLECTIVE COATING

The reflective coating is the top-most layer, sitting above the metallic flakes and the base layer. It implements a glossy reflection BSDF and is useful to simulate effects such as:

- clear coats
- varnishes
- Fresnel reflections on dielectric materials (such as plastic)



9.1 WEIGHT

The weight of this layer determines its opacity, which in turn also affects how much the other layers (metallic flakes and the base layer) are visible. The weight can be calculated in three different modes:

- **From weight only**
The weight determines the opacity of the layer directly, without any dependency on the incident angle.
- **Fresnel curve**
The weight is multiplied by a Fresnel curve, calculated using the provided index of refraction (IOR). This is typically the physically-correct approach to rendering varnishes, clear coats, and Fresnel reflections.
- **Custom curve**
The weight is multiplied by a Fresnel-like customizable curve, similar to the Arch & Design material. This method is intended to provide artistic control.



A blue diffuse base layer with a white reflective coating.

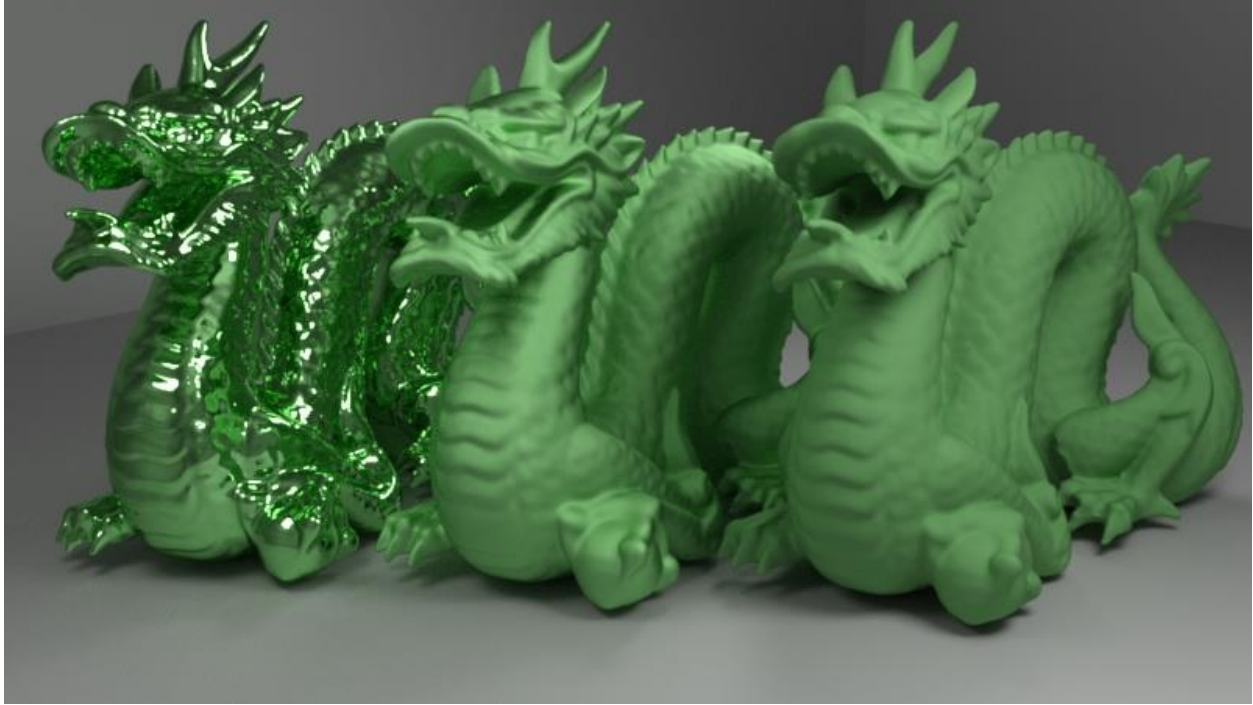
Left: from weight only (weight = 0.5)

Center: Fresnel curve (IOR = 1.5)

Right: Custom curve (0 deg = 0.2, 90 deg = 1.0, exponent = 5.0)

9.2 ROUGHNESS

The roughness determines how rough (or glossy) the surface is. 0.0 should be used for a perfectly smooth surface which will produce mirror-like reflections, while 1.0 will create reflections which are close to diffuse.



Left: roughness = 0.0

Center: roughness = 0.5

Right: roughness = 1.0

9.3 BUMP MAP

This bump map affects the reflective coating layer only.

9.4 SECOND GLOSSY COMPONENT

An alternative use of this layer is to create a material with two glossy components, each with their own roughness and color. To do this, use the “From weight only” weighing mode.



A silk material simulated using two glossy lobes, each with their own color.

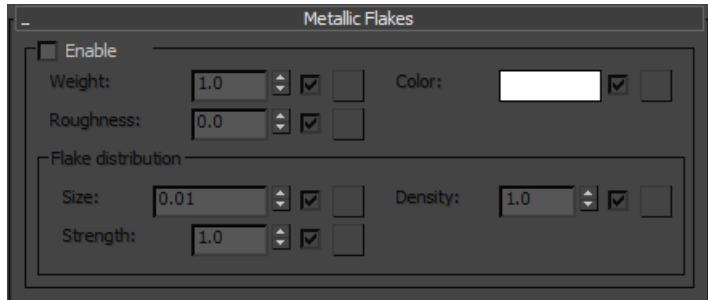
Left: base layer glossy component, 100% backscattering, roughness 0.8, dark blue

Center: end result with top layer weight of 0.2

Right: reflective layer glossy component, roughness 0.2, light blue

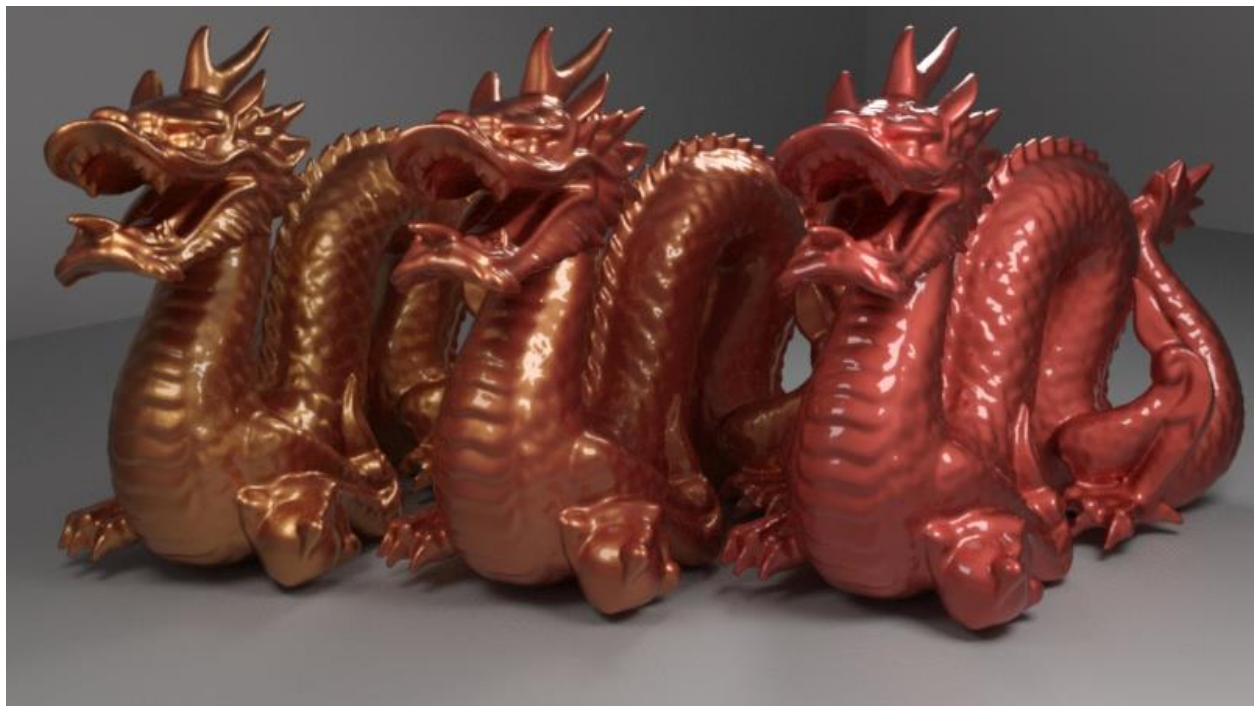
10 METALLIC FLAKES

This layer sits between the reflective coating and the base layer. It is designed for simulating metallic flakes, such as those found in car paints, but is also useful for simulating various sparkling materials.



10.1 WEIGHT

The weight affects the opacity of the layer. At 0.5, the metallic flakes are 50% transparent.



Red paint with orange flakes.

Left: flakes weight = 1.0

Center: flakes weight = 0.5

Right: flakes weight = 0.0

Note: the base layer is typically visible through the metallic flakes, even with a flake weight of 1.0, because the flakes do not cover 100% of the material.

10.2 ROUGHNESS

This is the glossy roughness of the BSDF used to shade the metallic flakes. A value of 0.0 produces a polished metal look; a value of 1.0 produces a satin metal look.

10.3 FLAKE SIZE

This value controls the apparent size of the flakes.



Left: flake size = 0.1 mm

Center: flake size = 10 mm

Right: flake size = 100 mm

Floor and walls: galvanized steel simulated using large flakes

10.4 FLAKE STRENGTH

This value controls the orientation of the flakes. Lower values create flakes which tend to be more parallel to the surface, and therefore less visible at grazing angles. Higher values create more random flake orientations, making the flakes visible from a wider range of angles.



Left: flake strength = 0.25

Center: flake strength = 1.0

Right: flake strength = 4.0

10.5 FLAKE DENSITY

This value controls the quantity of flakes which appear on the surface. A higher density makes the flakes more visible and the base layer less visible.



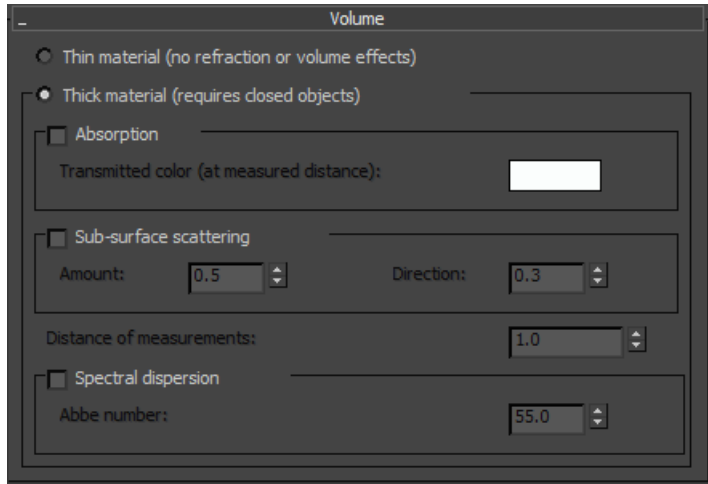
Left: flake density = 0.5

Center: flake density = 1.0

Right: flake density = 2.0

11 VOLUME PROPERTIES

If the base layer has translucency or refraction enabled, then the behavior of transmitted light is determined by these properties.



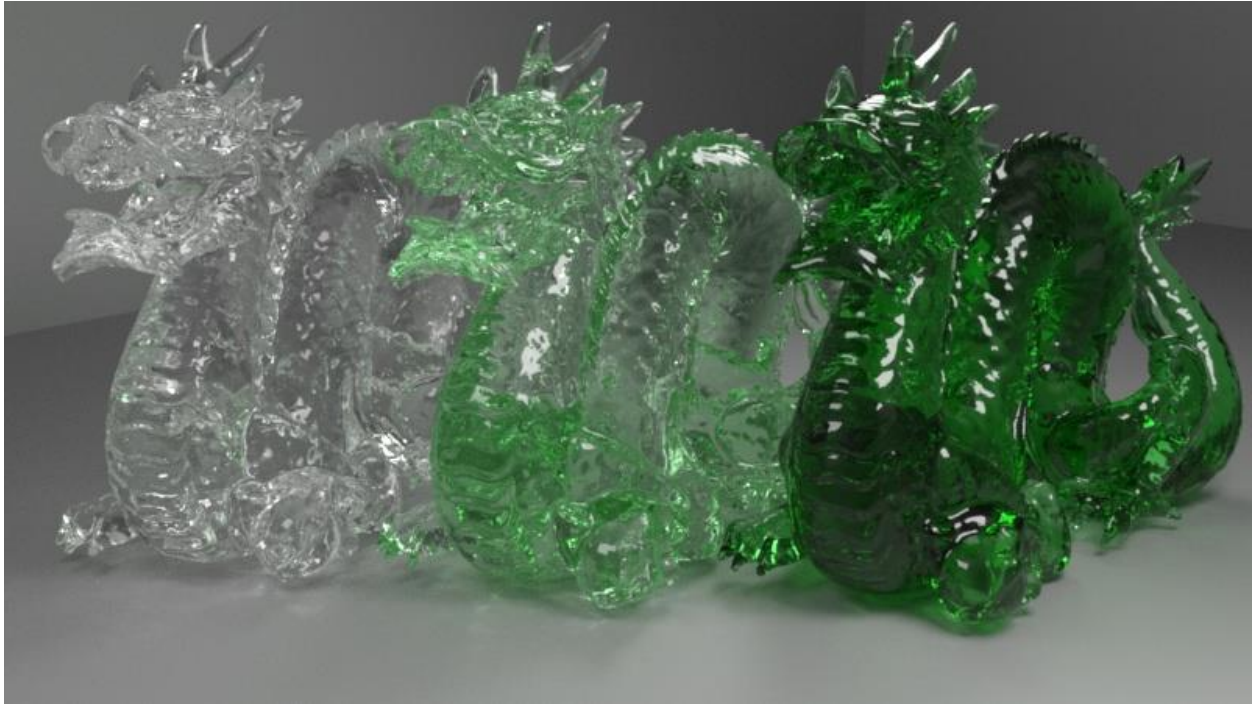
11.1 THIN & THICK MATERIALS

In the real-world, all materials are thick. But sometimes it helps to model thin objects (such as windows) using a single geometric surface. In these cases, "Thin material" must be selected to ensure proper behavior; otherwise, iray will behave as if the volume that lies beyond the window was made of glass.

Because thin materials do not enclose a volume and do not refract, all volume properties are unavailable unless "Thick material" is selected.

11.2 VOLUME ABSORPTION

This simulates the absorption of light as it travels through a volume; the longer the light travels in the volume, the more it is affected by absorption. The color controls the amount of light that is transmitted by the volume over the specified distance of measurement. For example, specifying a color value of (0, 0.5, 0) and a distance of 1 meter would result in 50% of green light crossing through a piece of material which is 1 meter thick.



Effect of measurement distance on volume absorption (transmitted color is the same green in all three cases).

Left: no absorption (green shading comes from reflections of other dragons)

Center: some absorption

Right: more absorption (by decreasing the distance of measurement)

11.3 SUB-SURFACE SCATTERING (SSS)

This simulates (in a physically-based way) the scattering of light in the volume. The amount determines how much of the light is scattered at the distance of measurement. For example, an amount of 0.75 means that 75% of the photons are scattered before they have a chance to travel through the specified distance of measurement.

The direction specifies what happens to a light path when it is scattered:

- 0.0: light is equally scattered in all directions (lobe is isotropic)
- Positive values: light is scattered towards the front, in a progressively narrower lobe (1.0 equates to disabling SSS)
- Negative values: light is scattered towards the back, in a progressively narrowed lobe (-1.0 is not advised)

The direction parameter is useful to control the efficiency of the sub-surface scattering simulation. Proper tuning it can minimize the length of the sub-surface paths with minimal compromise to the look:

- If the desired effect is for most light to go mostly through an object, positive values are best.
- If the desired effect is for shallow SSS effects, for example opaque plastics or skin, negative values can be useful.

It is best to experiment with these values and find a set which matches the look and performance desired.

Note that sub-surface scattering should typically be used in combination with volume absorption.



Left: SSS amount = 0.0

Center: SSS amount = 0.3

Right: SSS amount = 0.99

In this scene, the dragons get progressively whiter as the amount of sub-surface scattering is increased because most of the illumination is coming from the right and gets reflected by the sub-surface scattering effect. If illumination was coming from the back, the dragon would be much darker and more colored.

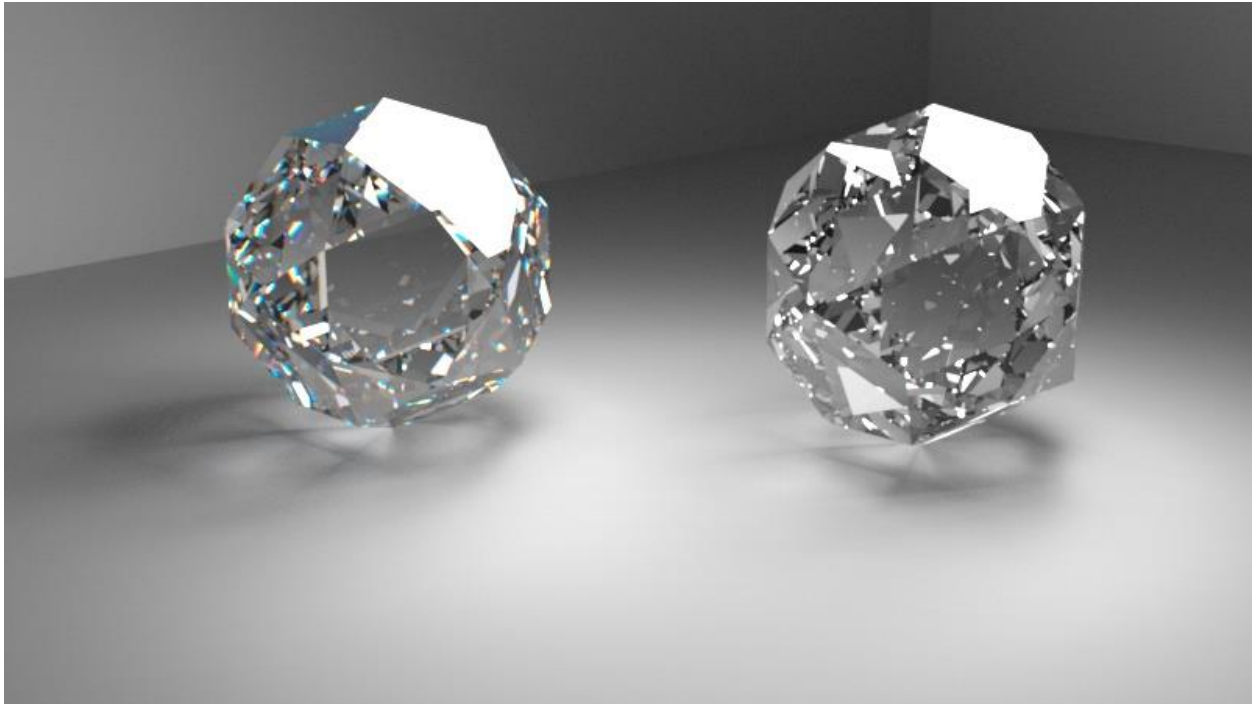
11.4 DISTANCE OF MEASUREMENTS

This is the distance at which the transmitted color and sub-surface scattering amount have been measured. Increasing this value make the volume less opaque and scattering.

11.5 SPECTRAL DISPERSION

This feature simulates the dispersion of color which, for example, creates the rainbow effect when light travels through a glass prism. This effect is very pronounced in diamonds and is crucial to rendering realistic jewelry. The Abbe number is a measurement of how dispersive a material is. The following web site is a useful reference for the indices of refraction and Abbe numbers of many common materials:

<http://refractiveindex.info>



Dodecahedrons with the same diamond material.

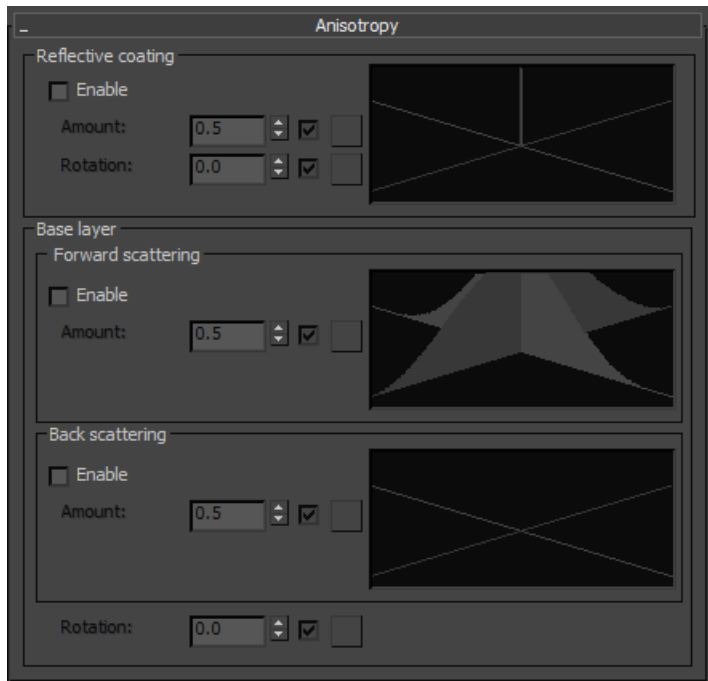
Left: dispersion is enabled

Right: dispersion is disabled

12 ANISOTROPY

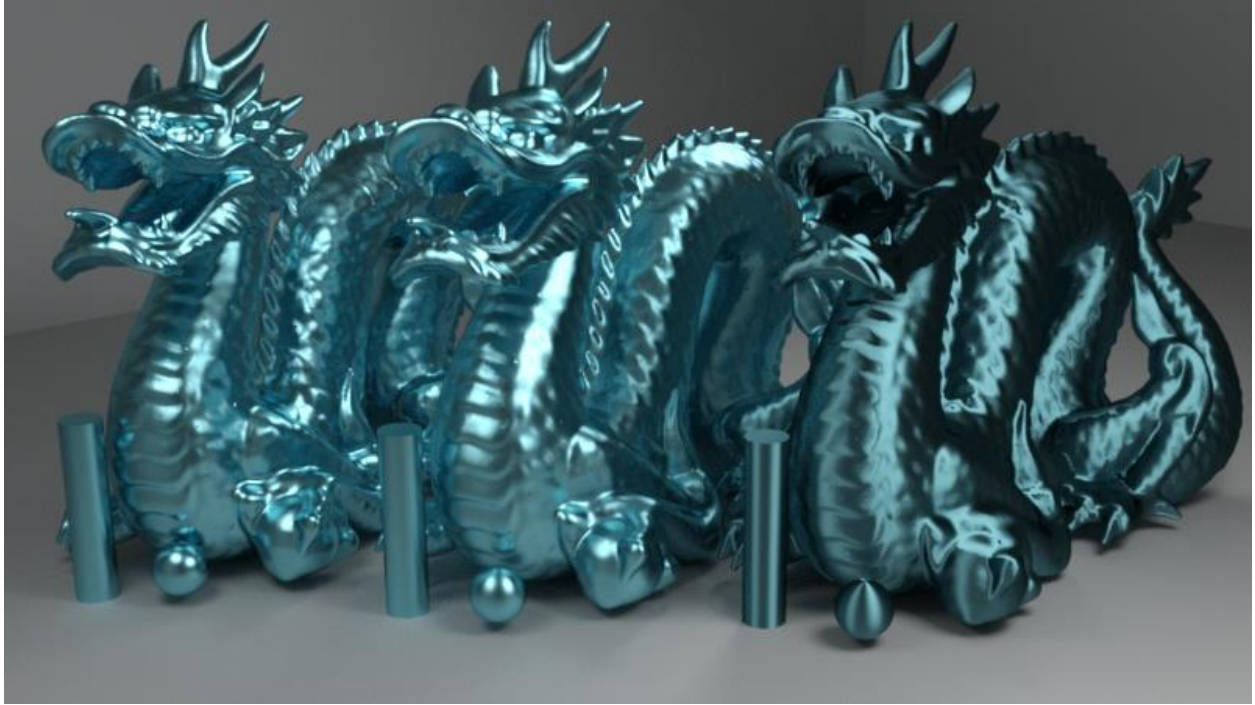
Anisotropy is a property of the glossy BSDFs to reflect and transmit light with a directional bias. It simulates small surface features, such as those created by brushing or sanding, which cause the material to appear rougher or glossier in certain directions.

Because anisotropy is specific to glossy BSDFs, it does not affect the diffuse component. Also, the glossy roughness must be larger than 0.0.



12.1 AMOUNT

The amount controls how much anisotropy is present. Higher values stretch the glossy lobe, making the material look rougher in one direction.



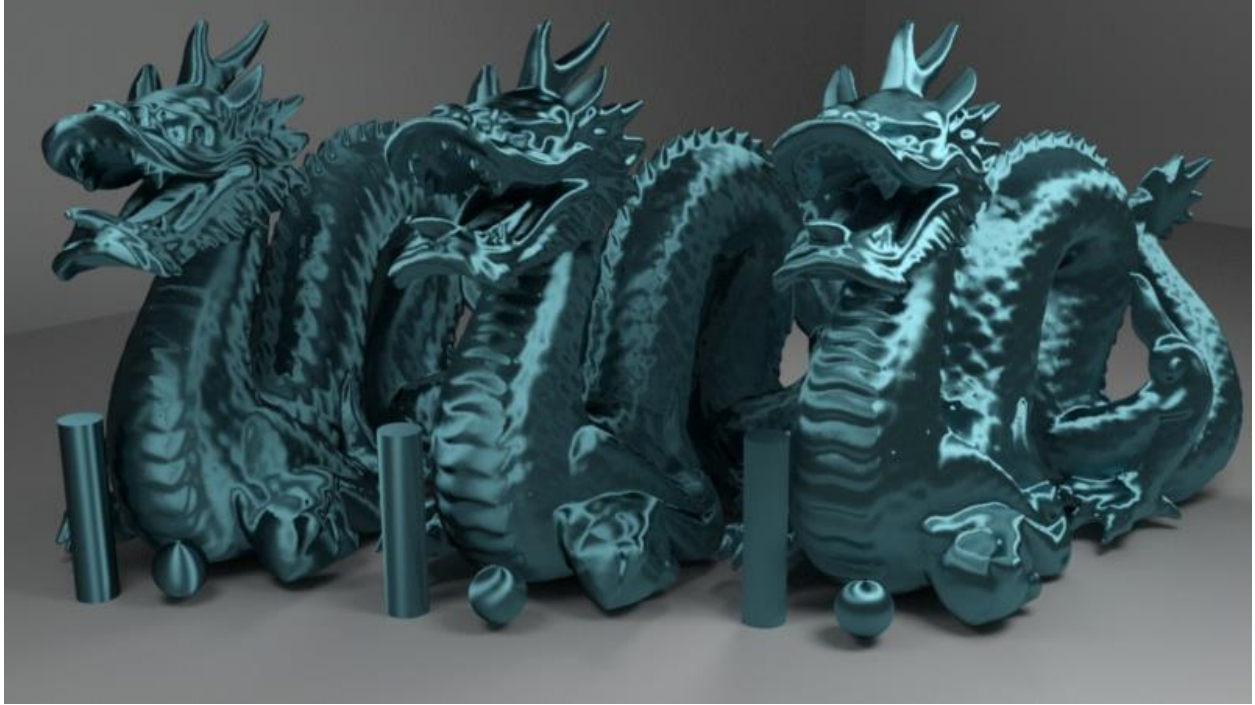
Left: anisotropy amount = 0.0

Center: anisotropy amount = 0.5

Right: anisotropy amount = 1.0

12.2 ROTATION

The rotation value changes the orientation of the anisotropy in UV space. At 0.0, there is no rotation, while at 1.0 the effect is rotated by 180 degrees.



Left: rotation = 0.0

Center: rotation = 0.25

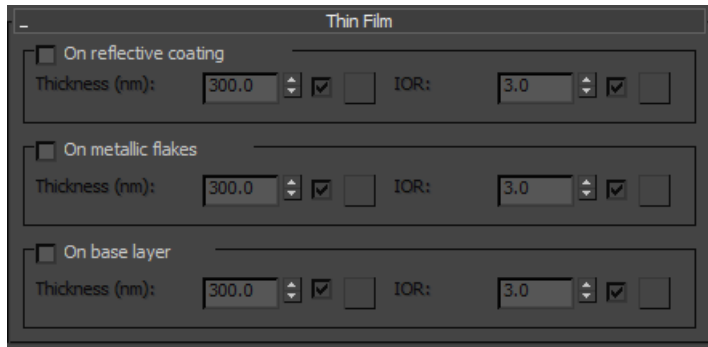
Right: rotation = 0.5

12.3 GRAPHS

The anisotropy graphs are meant to provide approximate feedback on the effect of the parameter values on the shape of the glossy lobe, as well as some insight on the relationship between roughness and anisotropy. The graphs are not a perfect representation of the final effect, but a useful hint.

13 THIN FILM

The thin film feature simulates color hue changes caused by very thin coatings of refractive material. When the thickness of the coating is close to the range of wavelengths of visible light, interference causes shifts in the hue of reflected light. The effect is observable on certain types of anodization (e.g. with titanium oxides, see <http://www.web-o-rama.net/titanium/1anodization.html>), heated metals, gasoline spills, soap bubbles, and so on.



A thin film coating can be enabled on each of the material's layers: reflective coating, metallic flakes, and base.



Satin-finish, uncolored aluminum with thin film coating.

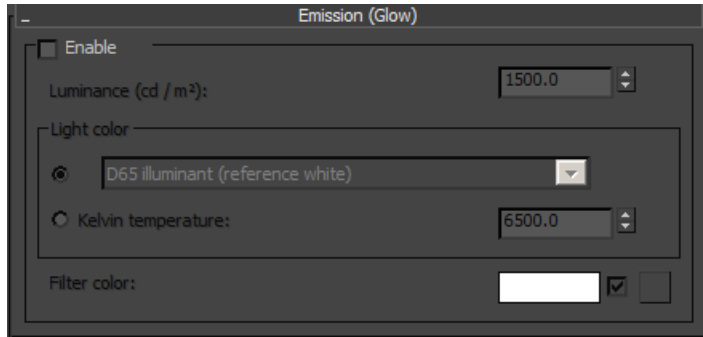
Left: thickness = 300 nm, IOR = 2.5

Center: thickness = 225 nm, IOR = 2.5

Right: thickness varies from 200 to 500 nm using a noise map (rgb offset = 200.0, rgb level = 300.0), IOR = 2.5

14 EMISSION

Emission is the property of the material to emit light. It is classically referred to as self-illumination or glow, but iray calls it “emission” to make it clear that the material will actually emit light, just as a regular light source.



The center dragon is emissive and uses a colorful noise texture as the filter color.

14.1 LUMINANCE

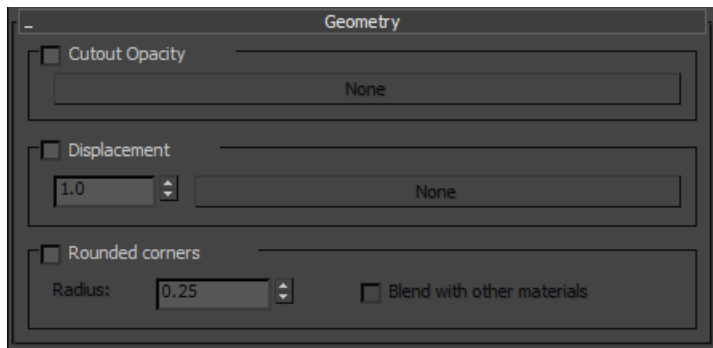
The luminance value specifies how bright the object looks. Because luminance is specified in candelas per square meter (cd/m^2), the dimension of the object has an impact on how much light is emitted. When using the default of $1500 \text{ cd}/\text{m}^2$ on an object which has a surface area of 1 m^2 , then the object will emit as much as a light source set to 1500 cd.

14.2 COLOR

The color of the emission is specified using a kelvin temperature, with several standard presets available from a drop-down list. A texturable filter color can also be chosen to additionally modify the color of the emitted light.

15 GEOMETRIC PROPERTIES

This set of properties affect the way the geometry is interpreted by the material.



15.1 CUTOUT

The cutout opacity map is used to make the surface transparent (without refraction). This is useful to create details which may be too expensive to model geometrically, for example the outline of tree leaves.

15.2 DISPLACEMENT

A standard displacement map, processed by mental ray at render time.

15.3 ROUNDED CORNERS

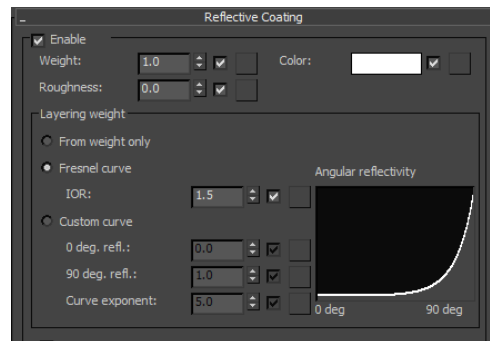
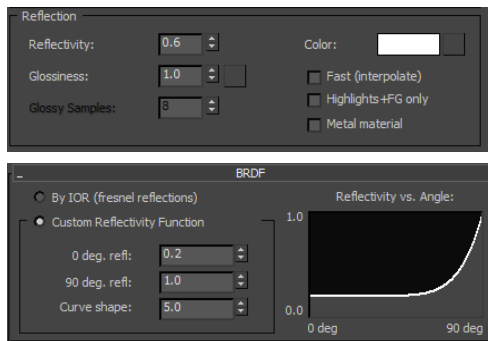
Rounded corners are a procedural bump mapping effect which alters the normal near geometric edges to create a rounded corners look. Optionally, the effect can be applied to corners that intersect different materials.

16 COMPARISON TO ARCH & DESIGN

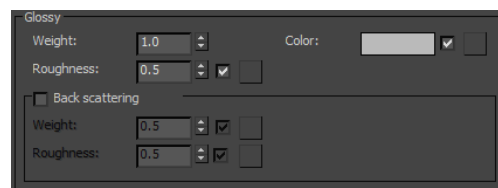
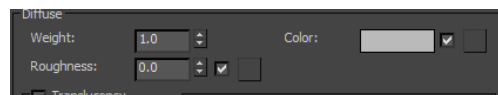
The design of the iray material was strongly influenced by that of the Arch & Design material, but both differ enough to make the transition a little confusing. This section highlights the major conceptual and functional differences.

16.1 REFLECTIONS

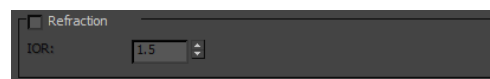
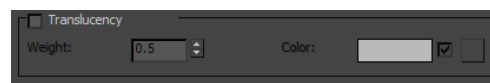
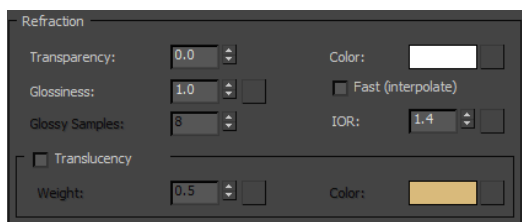
Both materials provide a reflection layer which sits atop the rest of the material and is blended using a user-configurable curve function.



Below the reflective layer, the Arch & Design material provides a diffuse BRDF only, while the iray material exposes a blend of a diffuse and a glossy BSDF, allowing for two layers of glossy reflections.



16.2 TRANSPARENCY

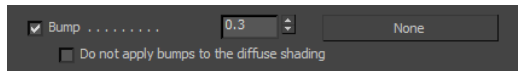


The Arch & Design material applies transparency below the reflective layer, by blending the diffuse reflection with glossy refraction and a diffuse transmission (translucency). The iray material uses a simpler, somewhat less flexible approach: translucency is a sub-component of the diffuse BSDF, while refraction does not expose a weight.

Refraction is therefore always weighted using a Fresnel curve, which helps guarantee consistent and photorealistic results.

16.3 BUMP MAPPING

The Arch & Design material exposes a single bump, which can optionally be applied to the reflection layer only.



The iray material exposes two separate bump maps for the reflective and the base layer, providing a bit more freedom.

16.4 METAL MATERIALS

The “metal material” checkbox of the Arch & Design material is not represented in the iray material. Instead, metal materials should be created by using a single layer with a glossy BSDF.

16.5 ANISOTROPY

The anisotropy value behaves differently in both materials. The Arch & Design material treats a value of 1.0 as isotropic, with values above or below 1.0 narrowing or lengthening the glossy lobe.

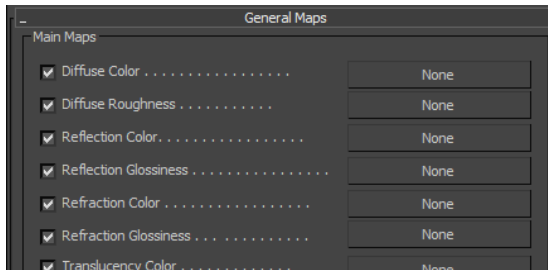
The iray material supports anisotropy values from 0.0 to 1.0, with 0.0 being isotropic and larger values lengthening the glossy lobe. The orientation of the lobe is strictly controlled by the rotation parameter, unlike Arch & Design which provides some orientation control in the anisotropy value.

16.6 GLOSSINESS VERSUS GLOSSY ROUGHNESS

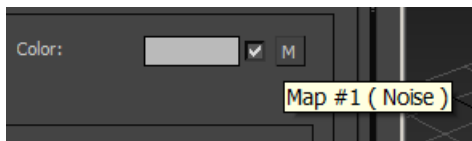
The Arch & Design material controls the shape of the glossy lobe using the “glossiness” parameter, with 0.0 being rough and 1.0 being specular. This definition of “glossiness” is slightly ambiguous as we typically think of glossy materials as not being fully specular, whereas a fully glossy materials (i.e. glossiness=1.0) is actually specular. The iray material therefore replaces “glossiness” with “roughness”, a concept which we believe to be less ambiguous and more natural: smooth materials create specular reflections, while rough materials create more diffuse reflections. Additionally, the behavior of the iray material’s roughness parameter should feel a bit more linear and predictable.

16.7 TEXTURE MAPS

The iray material does away with the traditional texture map rollup:



Instead, all texture functionality is integrated within the standard rollups:



The checkbox for enabling the texture map is next to the button. The texture map button has a tooltip which shows what a full-sized texture button would regularly display.