

Standard Shader/Material PBS and texturing

Checked with version: 2017.3 - Difficulty: Intermediate

Materials define how light reacts with the surface of a model and are an essential ingredient in making believable visuals. Once a model is created, it is time to define its surface properties.

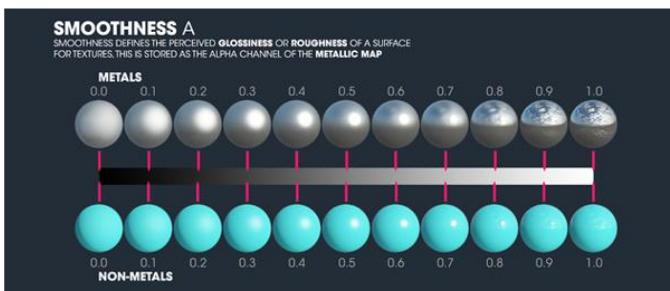
Physically Based Rendering Shader innovations have had a massive impact on real-time rendering. It has done more to let us achieve believable visuals than anything since the normal map innovation comes along. The Unity Standard Shader is a great Shader that allows content creators to create plausible materials easily. It is highly recommended to master the use of the standard shader before veering off into making custom surface shaders in ShaderLab, ShaderGraph (Scriptable Render Pipeline) or other 3rd party Shader creation tools.

[More detailed explanations for the Standard Shader in Unity can be found here.](#)

While PBS allows you to easily create believable materials, just playing with the slider and color pickers on the Material will not get a content creator too far. Most real life surfaces are made up of multiple materials. Here are few things to keep in mind for a DCC to achieve their goal when texturing an object with the Unity Standard Material. To keep things simple, only Albedo, Smoothness, Normal Map and AO covered here.

- **Standard or Standard Specular Setup.** In Unity there's two option in Standard Material, there's Standard and Standard Specular Setup. Few things to be aware off for these two material:

- In general it is easier to use Standard setup material as the Specular brightness and color are calculated automatically based on Albedo, Smoothness and Metallic input.
- In Standard setup material, Metal at 1 means the albedo drives the color of the specular and its brightness in tandem with smoothness that adjust the brightness and glossiness of the surface.



Metal at 0 means the albedo color don't affect the specular color and show up as surface color.

- The Standard Specular Shader should be used when you want to untether the specular color from the material's albedo. This is the case in some more exotics material.

[More information can be found here.](#)

- **Albedo values and Material Validator.** While a Physically Based Shader is working hard to properly model energy conservation (automatically calculating specular brightness and distribution from the light), the albedo of your material needs to be plausible. A material's Albedo effects both direct and indirect lighting, and an unrealistic value will propagate through the rest of your Scene lighting.
 - A very dark albedo will absorb light significantly and causes unusual lighting response. A too bright albedo reflects significant amounts of light and indirect color that are not usually observed in real life.



Creating Believable Visuals

Staying On Track

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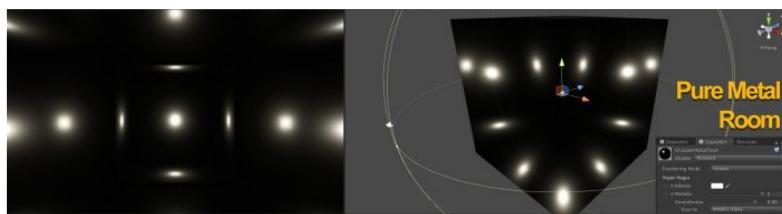
Above sample showcase Albedo on non metal surface affecting indirect lighting.

- While there's a chart of material people refer to for determining values for PBS, there is no defined value for non metal painted surfaces, which are very common in real life. Content creators can decide that a wooden wall is painted with charcoal black or white snow paint for example. There's no single definitive value of that wall albedo other than the content creator preference. This is where the general guidelines comes in. It is safe to say that for a non metal, painted surface an albedo value below 0.2 is too dark and an albedo value above 0.8 is too bright. This is not a scientific measurement but simply an easy to remember guideline. [A chart of proper PBS values can be found here.](#)

For darker dielectric material information, please refer to this expert guide.

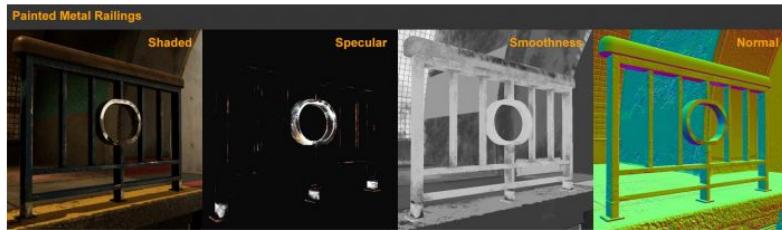
A chart can be simple to use when dealing with a single albedo surface, however determining validity of complex albedo textures can be difficult. Our rendering engineer on the Spotlight team developed a Material Validation tool for exactly this reason. This tool allows you to check whether material values follow the guidelines or not. This tool can be enabled in Scene viewport, switch from "Shaded" to "Material Validation" view.

- **Metallic values** The Metal value of a material defines how much of the environment gets reflected to the surfaces while also determining how much of the albedo color visible on the surface. When a surface is pure metal, the surface color (albedo) drives the color of the environment reflection. A few things to keep in mind with metal materials:
 - Pure metal gloss materials don't bounce diffuse lighting. If your entire room is made out of metal, your room will be very dark and you can only see specular highlights and reflection.



Above example showcase how dark a smooth metal room with full pointlight coverage.

- Deciding whether a surface is a metal or not can sometimes mix up content creators. Don't get caught by the object core material, but pay attention to the final surface of an object. As an example, metal railings that is "painted" blue should only have their unpainted area designated as metal. The image below illustrate how a painted metal railing should be textured.



NOTE: While the chipped area of the painted metal bar is metallic, rust however is not metal a surface.

- While it is easy to imagine that material only needs either a metal value 0 or 1, there are cases where surface materials are mixed in / blended. Metal objects partially covered with dust or dirt is a good example where the value of metal is in between due to blending. Other than that, be really cautious to not use metal value in between 0 and 1 when creating plausible material.

More information about metal can be found [here](#).

- **Smoothness value.** Smoothness controls the microsurface detail of the surface, a value of 1 will yield a pure reflective mirror like surface and a value of 0 will yield a very rough and dull surface. This is often straightforward and intuitive, but at other times can be downright confusing. A few things to keep in mind:
 - Focus on the final surface quality of the object. Just because an object made of concrete, it doesn't mean anything to the smoothness. It could be a rough surface concrete with a gloss paint on top of it. Another example is unpainted wood, how the wood got polished determines the final smoothness value.
 - Don't forget scuff, dirt, scratches and water stains. In real life the surface of a material gets affected by many variable and rarely are they a pure single surface.
 - How elements gets blended between surfaces also determines the characteristic of the material. (e.g. a water puddle on soil usually have a ring of absorbed water that has darkened the albedo instead of just a direct smoothness blend).



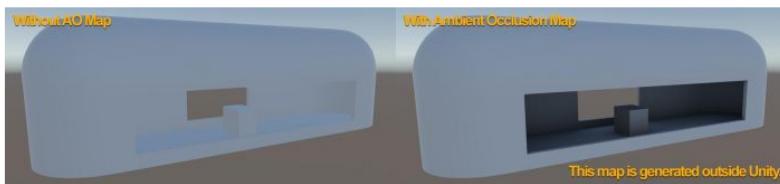
[More information for smoothness can be found here.](#)

- **Normal Map.** A "normal map" usually refers to a tangent space normal map that bends the surface normal of a polygon as if the light direction comes in from the other direction. This is usually used by content creators to add many details on a seemingly simple mesh. While normal maps are usually used to add geometric details, it is important not to forget its role in defining a material. It can be used to show the original surface material, as an example, this wood painted with high gloss red finish.



[More information about normal map can be found here.](#)

- **Occlusion map.** Occlusion map mimics the attenuation of ambient light and can enhance the perception of concavity and shape.



Why would we need this, since we already have light baking and an indirect lighting solution and SSAO (Screen Space Ambient Occlusion)? The answer is two fold.

- First, a detailed version of the occlusion map can be achieved at much higher quality during offline render especially if the data is coming from a higher detailed model (similar to normal map baking from high detailed model to low).
- Second, occlusion maps help dynamically lit object tremendously since dynamic objects don't get occlusion from light baking and only receive Light Probe or ambient lighting and low detail Screen Space Ambient Occlusion (SSAO).

[More information about occlusion maps can be found here.](#)

- **Reference picture, colour chart and photo source.** Like trying to learn any new field, studying up on the general principle behind Digital Content Creation will make your results better. Taking pictures of the surface whether it's for reference or texture source often times helped speed up the creation of surface material in digital content creation tool. There are not many rules for capturing reference, other than taking lots of pictures of the particular subject. It's the equivalent of going to image search engine and searching for specific reference image.

On the other hand, taking pictures for texture source needs some guidelines in order to give DCC close enough results for texture capturing:

- Neutralizing colour cast and negating light brightness effect of the surface is key. White balancing and proper exposure of an 18% grey card (such as Kodak R-27 card) comes into play here.



The point of the 18% grey card is a known trusted value to be used as an anchor in taking texture source pictures. Do not try to print your own 18% gray card as this most likely gives you inaccurate gray card and off balance color. A proper 18% gray card is equivalent to $rgb(124,124,124)$ or $\#7C7C7C$ in sRGB color space. This gray card is then used by the camera to acquire the proper exposure (Negating light brightness) and do white balancing (neutralizing the light color cast). [More information of gray card can be found here.](#)

- While it's nice to use Digital SLR / advance camera, it is not a requirement. Any camera, including a mobile phone, with manual exposure control and RAW capability can achieve good result with the above setup.





- To take it further, a X-Rite ColorChecker profiled RAW image with polarized lighting and lens will produce higher accuracy in capturing of albedo texture.



Like the R-27 gray card, ColorChecker chart is a known trusted color reference that can be used as anchor. Camera sensor + lens + filter + lighting condition characteristic profile can be generated and be used to correct RAW images.

- Lighting condition when capturing a texture source need to be in diffused condition, such as cloudy day or in evenly lit shades.
- For purer albedo texture once the captured image are processed, additional processing using Unity's de-lighting tool can be done.

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