DOTA 2 - Character *Shader Masks Guide*

How to author shader masks to design detailed materials for heroes and items.

Masks

Color

Normal

Mask 1
R - Detail map mask
G - Diffuse/Fresnel mask
B - Metalness
A - Self-illumination

Mask 2
R - Specular Intensity
G - Rimlight Intensity
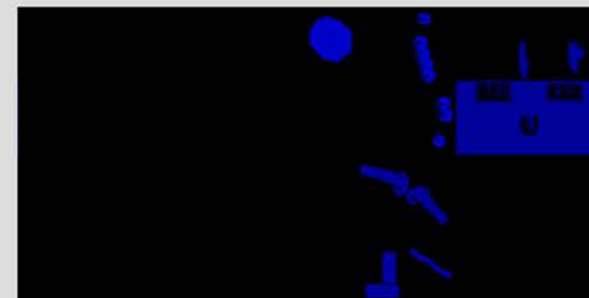B - Tint spec by base color
A - Specular exponent

The hero shader in Dota 2 is extremely powerful, capable of many high-end material properties. Every hero, item, courier and creep makes use of the shader.

The individual Red (R), Green (G), Blue (B) and Alpha (A) channels of every mask texture each serve a specific function for the material properties. The shader supports eight different grayscale masks combined in two Mask textures as well as the Color and Normal maps.
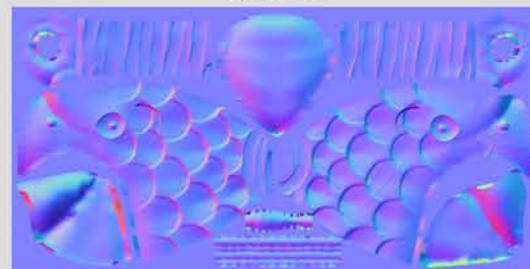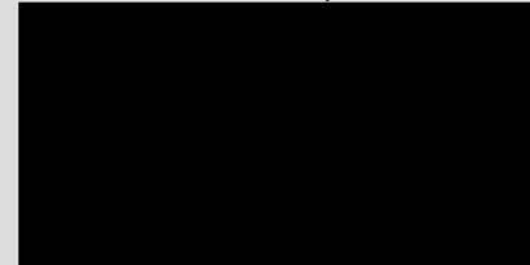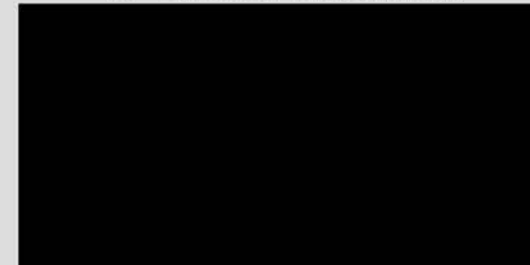
Overview

Color
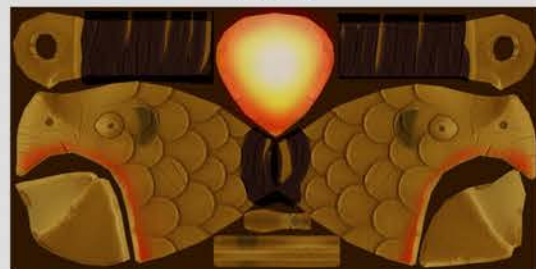
Normal

Mask 1

R - Detail map mask
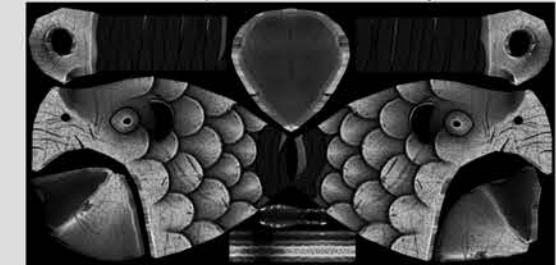
G - Diffuse/Fresnel mask

B - Metalness

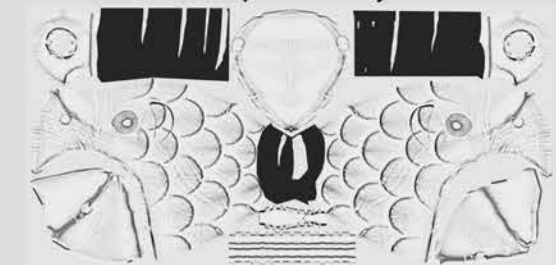A - Self-Illumination mask

Mask 2

R - Specular Intensity

G - Rimlight mask

B - Tint Specular by Base
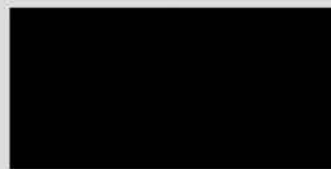
A - Specular Exponent

Each texture works in conjunction with all the others. A good first step to starting a mask texture is to create a selection for various surface types or parts of the model, and then reuse those selections to fill in each mask channel. In the example above, the leather straps are obvious in almost every mask.

Some masks, like the Detail map mask and the Diffuse/Fresnel mask, are only used on certain heroes. The majority of item masks have black in those channels. In order for blank maps to render correctly at least one pixel of information of the opposite mask value must be present. Even if a mask is not used, it is always stored in memory for each item.

Specular Intensity - Mask 2 Channel 1 (R)

Specular Mask Channel

No Specular

Full Specular
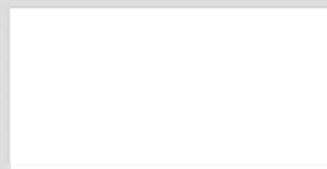
Authored Specular
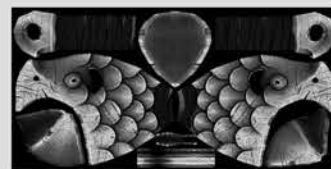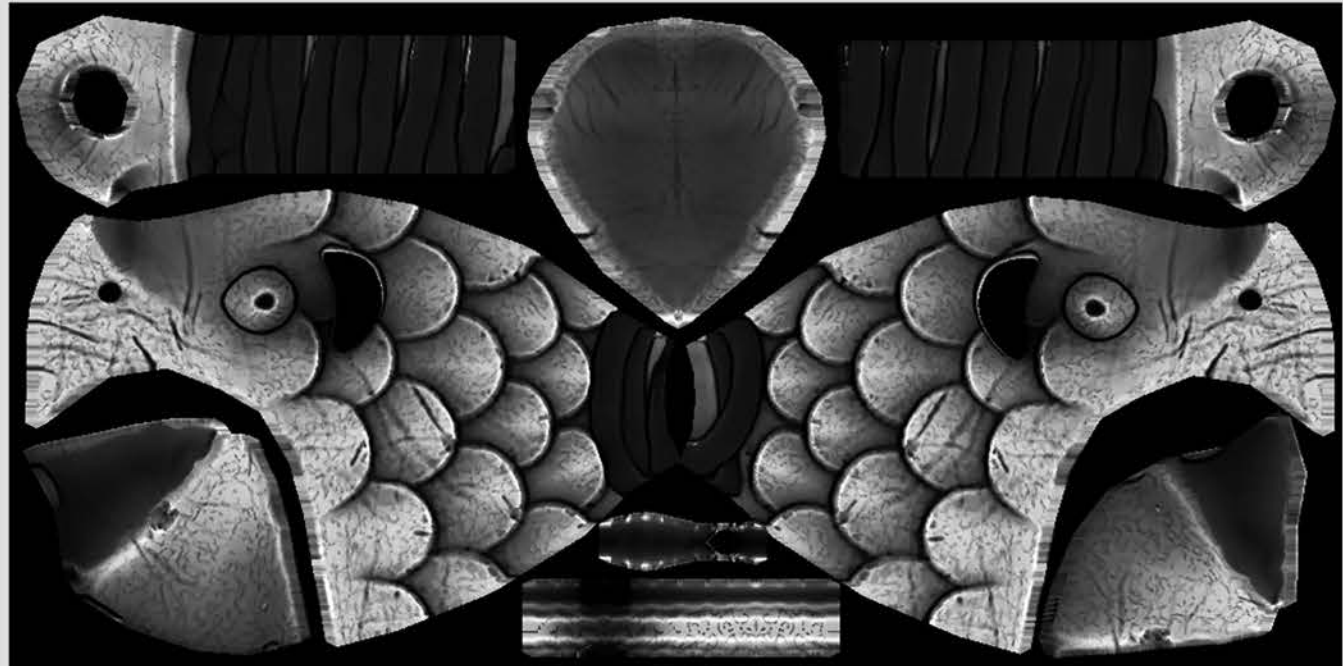
- An Ambient Occusion map is a good base for this map
- This channel works in tandem with the Specular Exponent channel

Specular intensity determines how bright the highlights are.

Specular intensity values from the mask are multiplied by the $SPECULARSCALE value from the material. In most cases specular scale is a number higher than 1, which results in exaggerated highlights.

Rimlight Intensity - Mask 2 Channel 2 (G)

No Rimlight Intensity

Authored Rimlight Intensity
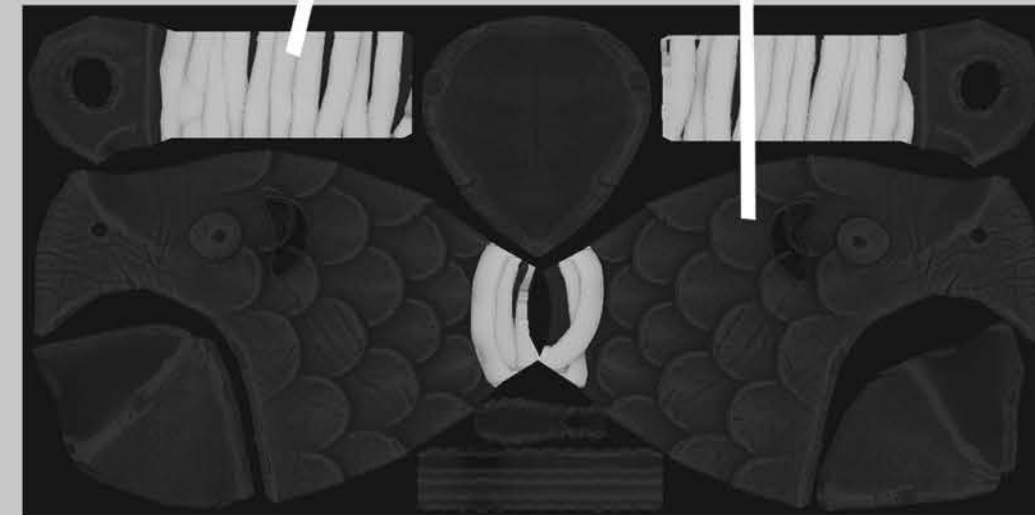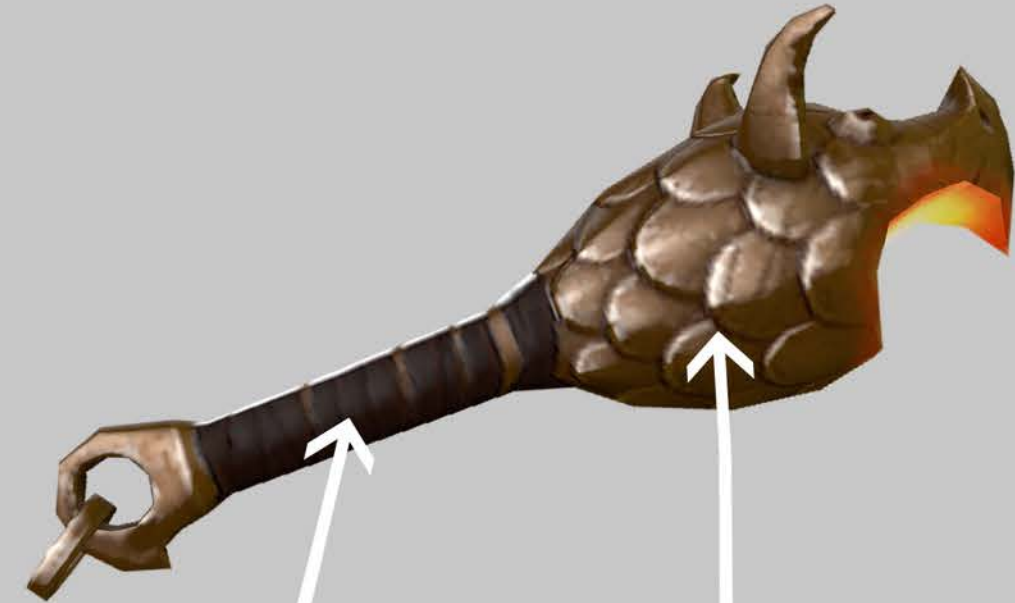
- Darker values were used for metals, and lighter values for skin/leather/wood (although that may not be the case for all items)
- Darker values in crevices (Ambient Occlusion)

Rimlight is the highlighting of the edges around a model to help it stand out from the environment.

Rimlight intensity values from the mask are multiplied by the $RIMLIGHTSCALE value from the material. In most cases, rimlight scale is a number higher than 1, which results in an exaggerated rimlight.

Tint Spec by Color - Mask 2 Channel 3 (B)

Specular Coloring from Color texture

No Tint Spec by Color, specular color from light. Notice white highlight.

Color

Tint Spec by Color

Specular Coloring from Color texture

No Tint Spec by Color, specular color from light. Notice white highlight.

Color

Tint Spec by Color
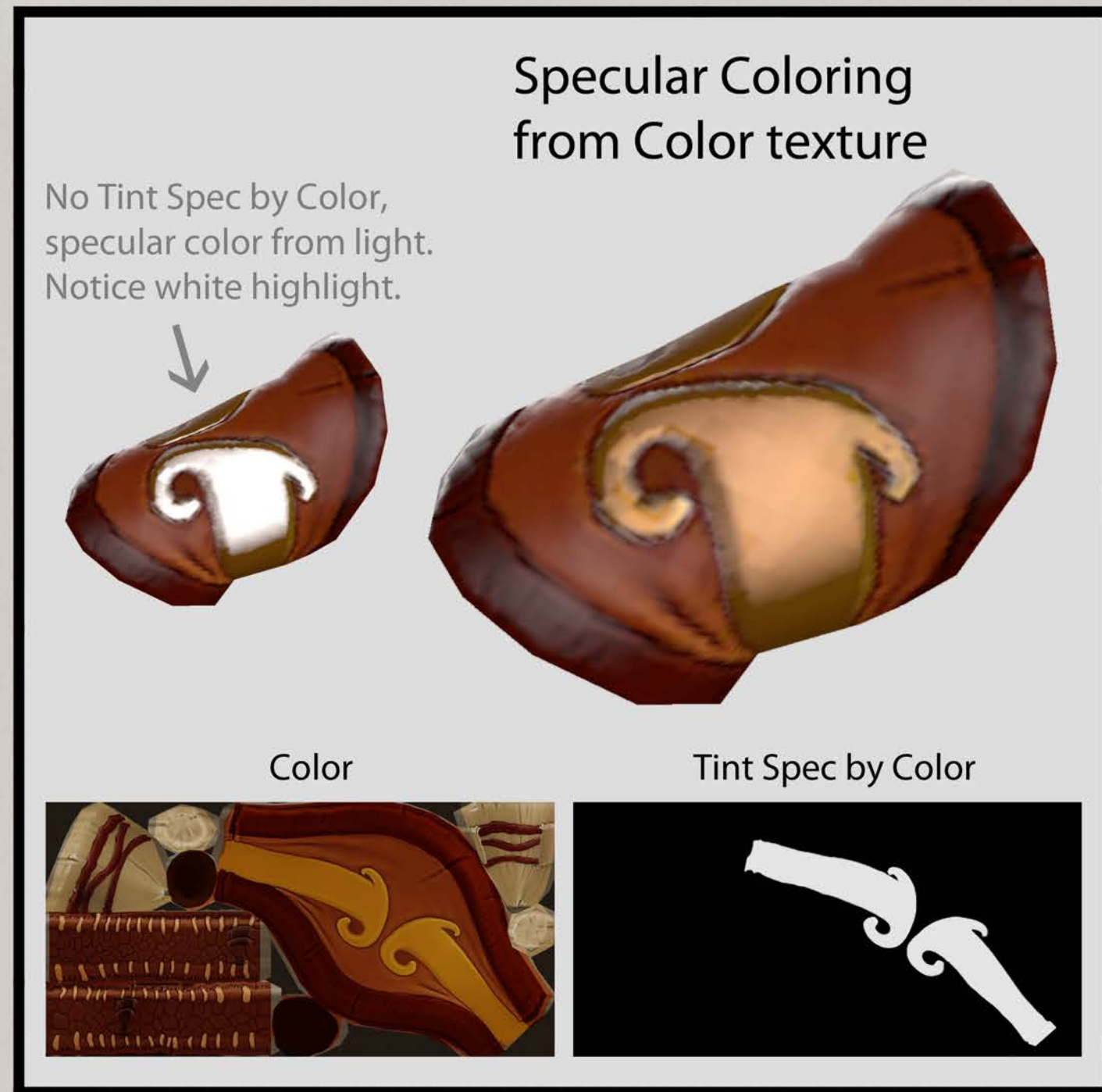
This is a special usage mask which gives specular highlights the coloring from the color texture. It is useful for colored metals (such as gold), or to simulate light penetrating a surface and being reflected back with color, making the surface appear fleshy.
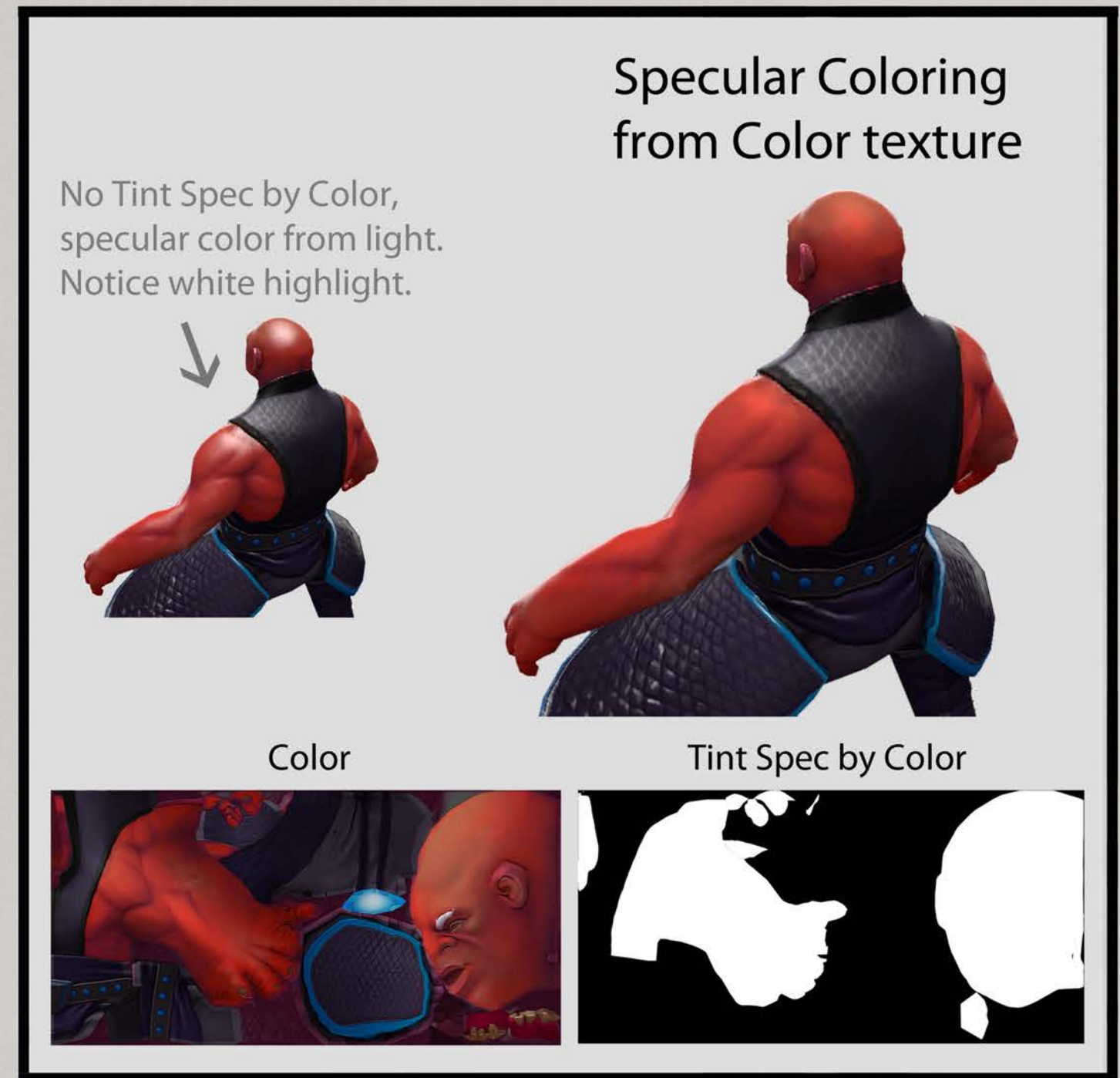
The default values here are black. White values will make specular highlights take on the coloring from the color texture.

Specular Exponent - Mask 2 Channel 4 (A)

Specular Highlight

Specular Exponent Values

Full Specular Exponent

Authored Specular Exponent
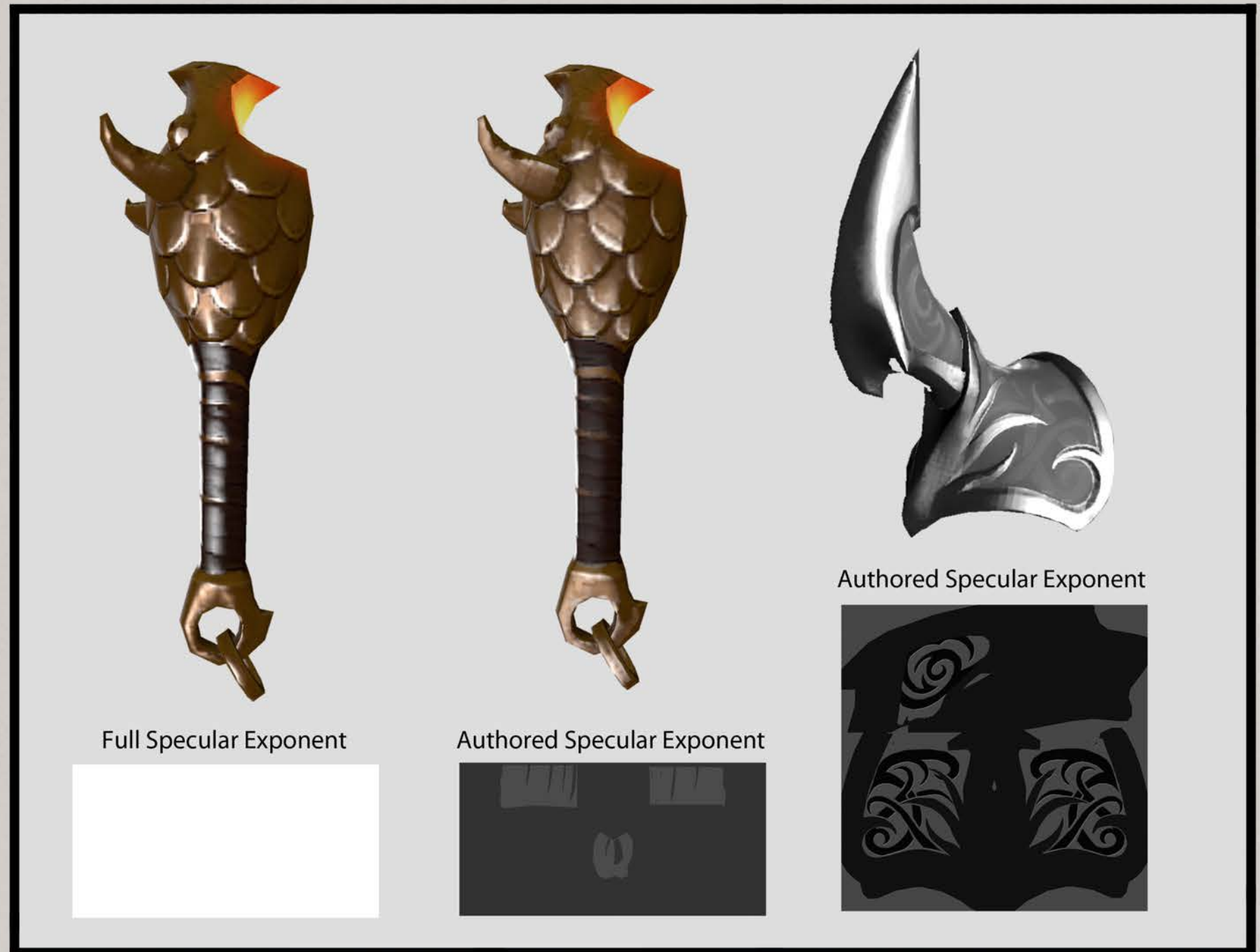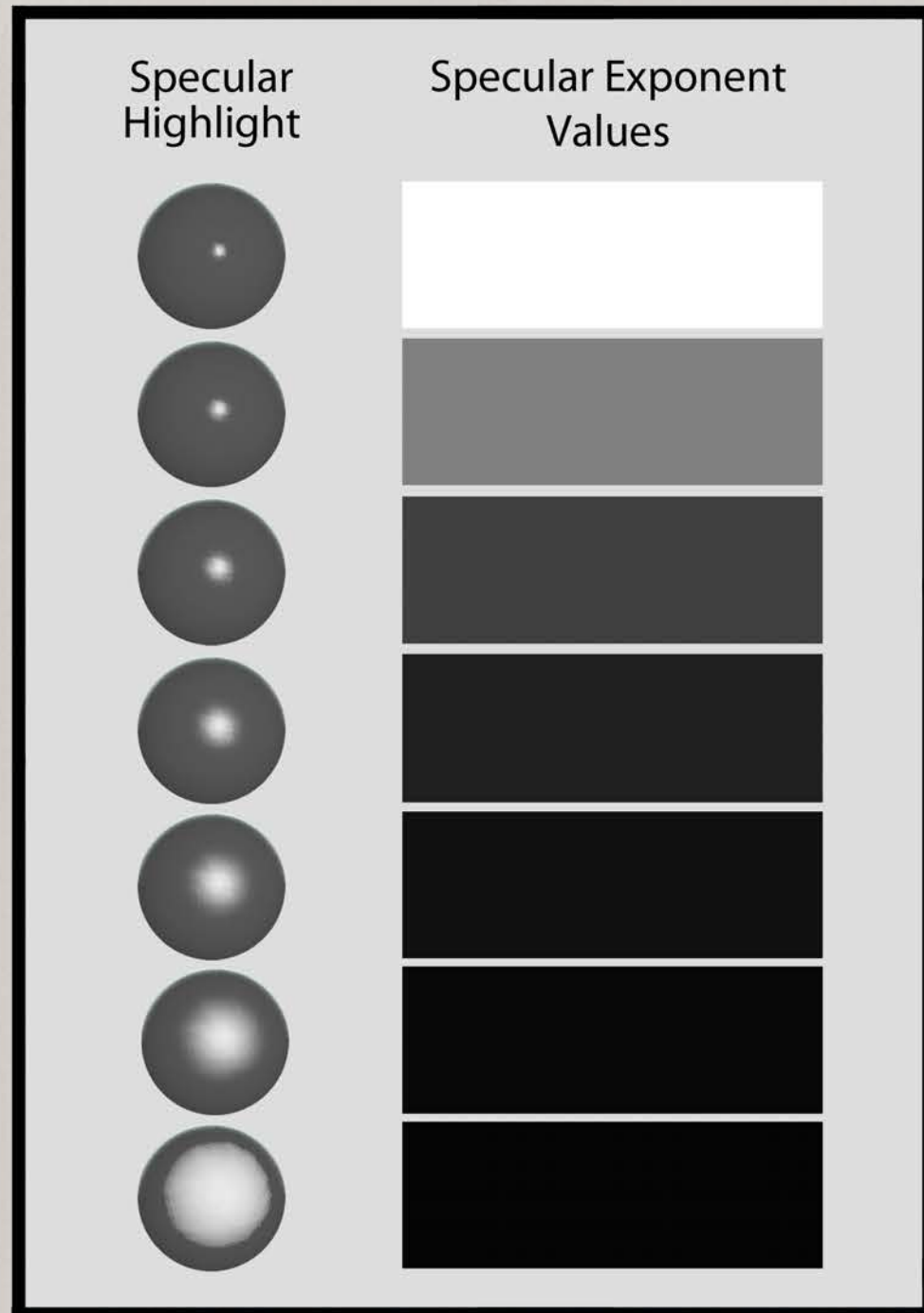
Authored Specular Exponent

Specular exponent values determine the size of the specular highlight on a surface. Rougher surfaces will have a dark value; polished surfaces, a light value. Specular intensities and exponents work together to create different surface types. Examples include: metal (high spec, medium exp), leather (medium spec, high exp), and wood (low spec, very low exp).

Values in this mask channel act as a scale for the specular exponent value from the material. If the entire channel is white, then the entire surface will inherit specular exponent values from the material.

Detail Map Mask - Mask 1 Channel 1 (R)

No Detail map mask

Detail map mask applied

Detail Map Mask

Detail Texture
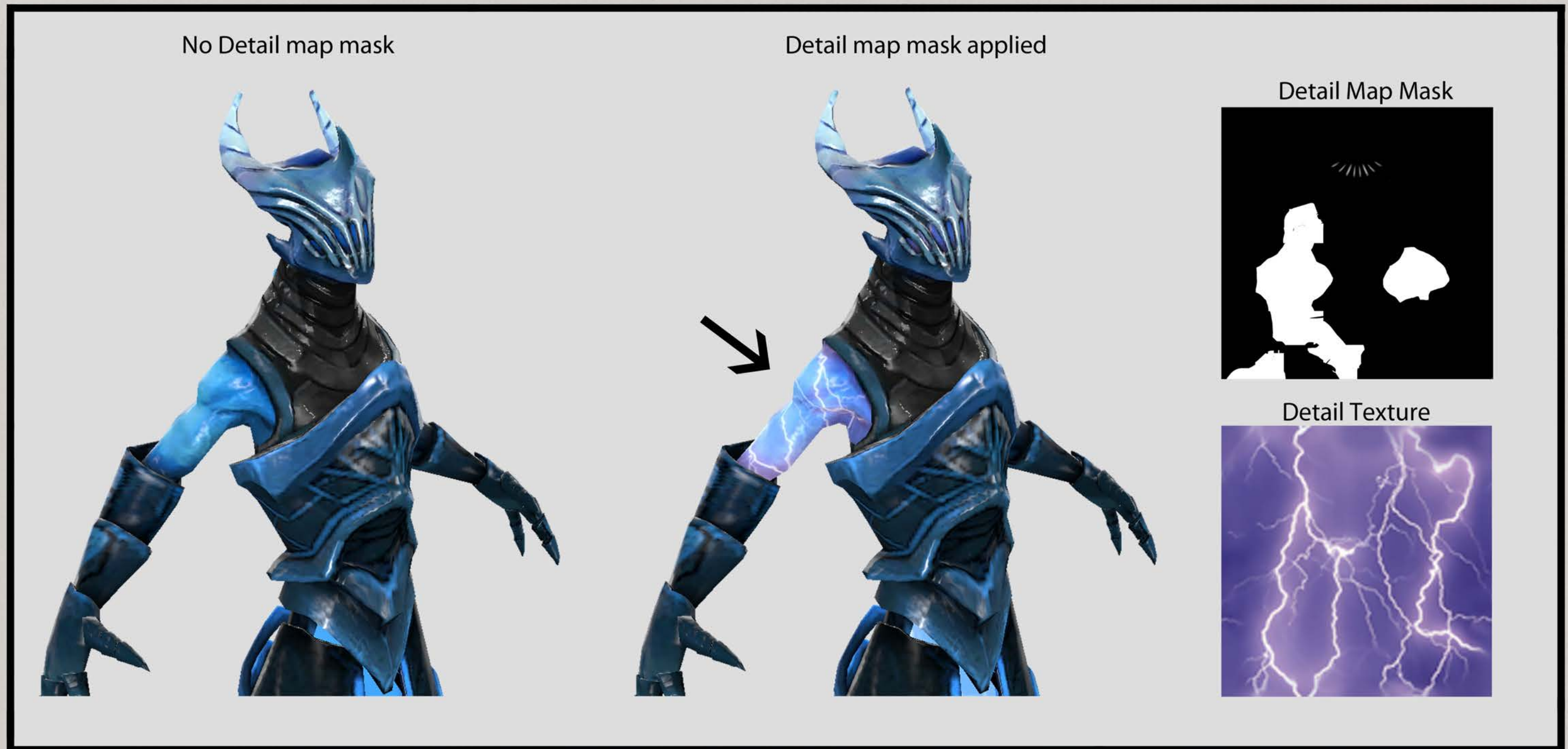
The Detail map mask determines where the detail map (if specified in a hero's vmt) will show up on the surface. It is used mostly for special effects. The majority of the heroes are not using the detail map mask features.

The default values here are black. Lighter values will make the detail map appear. The material controls the blending mode for the detail map. In the above case an additive blend mode is being used.

Diffuse/Fresnel Color Warp Mask - Mask 1 Channel 2 (G)

Default
Half-Lambert

Custom
Diffuse Warp

The most noticeable difference that the Diffuse Warp on the head provides is a green tint within the shadows.

Diffuse Warp Mask for Head

Diffuse Warp Mask for Torso

Diffuse Warp Mask

White Diffuse Warp Mask selects upper gradient

Diffuse Warp Mask

Black Diffuse Warp Mask selects lower gradient

*Diffuse Warp Mask

*Grey Values in Diffuse Warp Mask select in-between areas of gradient

No character pictured for this example

The diffuse warp texture allows you to create custom, stylized lighting. They contain gradients that define how the lighting is modified. The values on the left of the gradient replace the darkest lighting. The values on the right of the gradient replace the brightest lighting. If a character's material does not include any warp textures, this mask has no effect.

Diffuse warp textures can contain multiple gradients, arranged vertically. The diffuse warp mask is used to select which gradient to use on a specific part of the model. A black diffuse warp mask will select the gradient at the bottom of the diffuse warp. A white one will select the gradient at the top. Juggernaut only uses two gradients. Diffuse warps can be authored such that they blend from one gradient to another, in which case the diffuse warp mask can select any of the in-between gradients using greyscale values*.

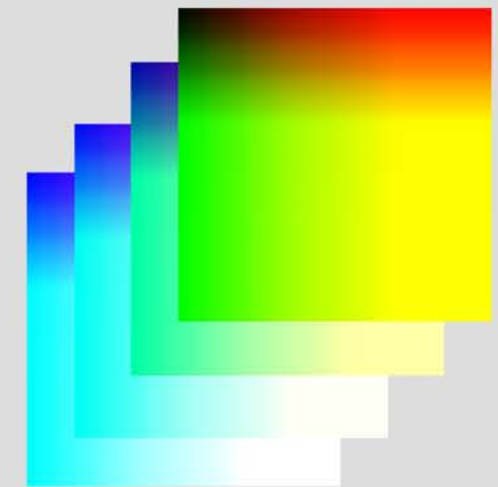# Diffuse/Fresnel Color Warp Mask - Mask 1 Channel 2 (G)

Original

Modified with Custom
Fresnel Color Warp

Fresnel Color
Warp Mask

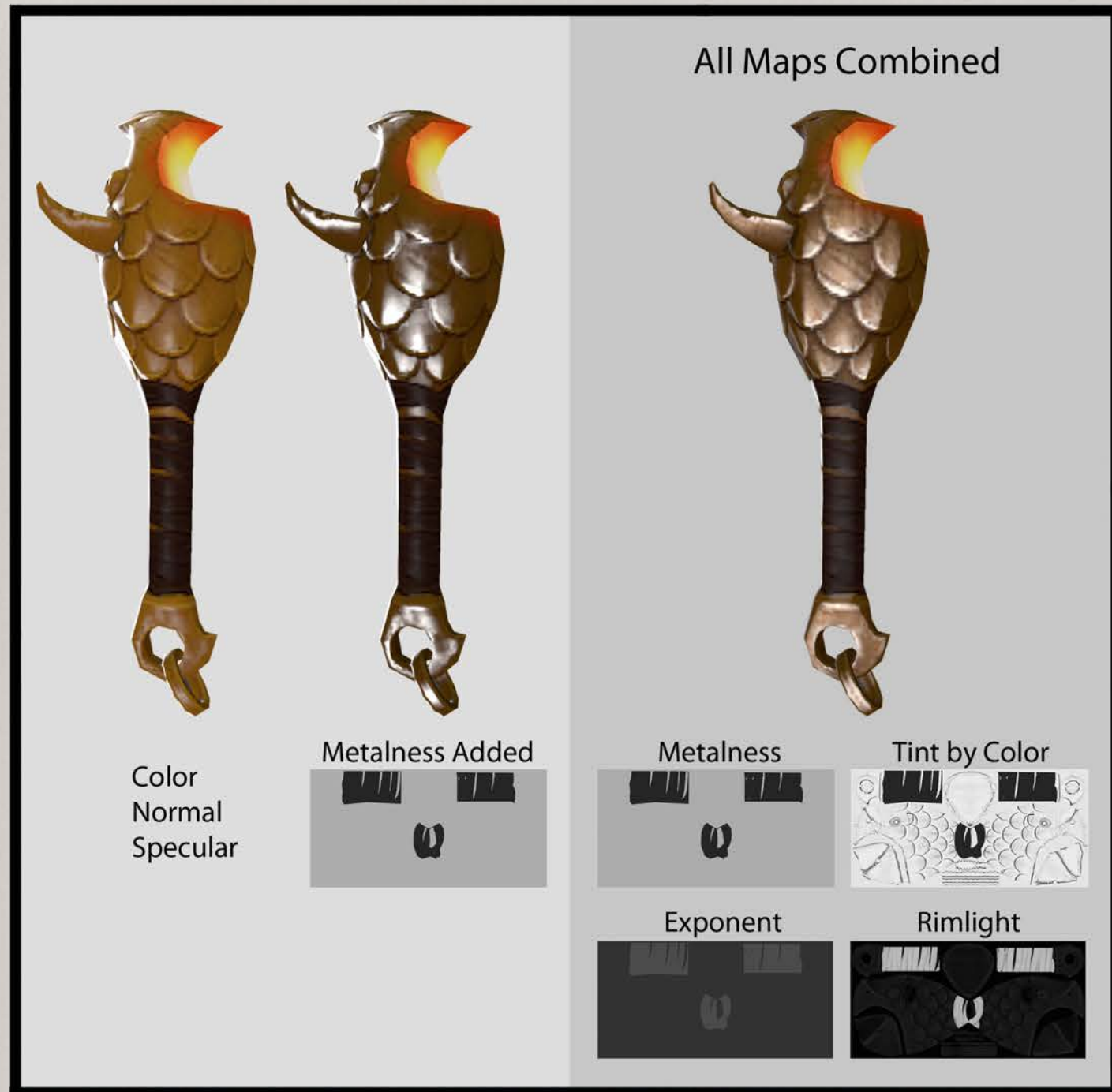Custom Fresnel
Color Warp
(3D Texture)

Notice the blue-green tint in the Custom
Fresnel Color Warp is visible around the edges
of the body of the model with the Fresnel Color
Warp Mask applied, but is not visible on the
wings as that area is dark in the mask.

This mask controls another special effect. We can apply a color transformation, like a hue shift or a contrast adjustment to the original color. We encode this transformation into a 3D texture called a colorwarp. In the example above, the color transformation shifts many colors towards a bright cyan, replacing the colors from the original texture.

This effect is then applied using a fresnel term, meaning it only appears around the edges of the character.

Metalness - Mask 1 Channel 3 (B)

Color
Normal
Specular

Metalness Added

Metalness

Tint by Color

Exponent

Rimlight

All Maps Combined

Color
Normal
Specular

Metalness Added

Metalness

Tint by Color

Exponent

**Rimlight**

All Maps Combined

The Metalness mask reduces and darkens the color and rimlight in order to simulate a real-world metal look. It works in combination with the mask Tint Specular by Base Color (mask 2 blue channel), which returns the color through specular highlights.
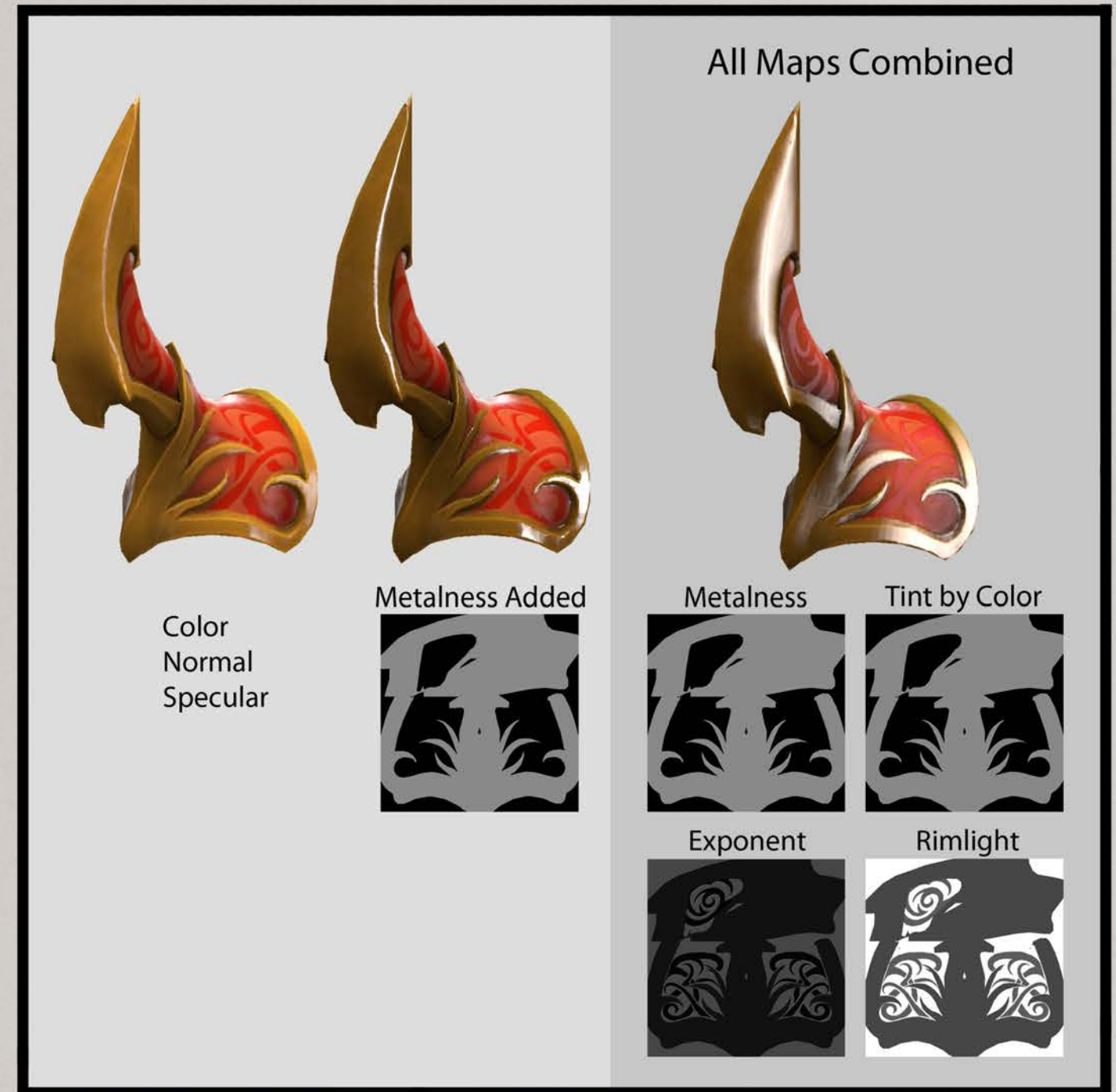
This mask is used sparingly and only in combination with other masks that help the surface appear more metallic. Typically this means bright, broad highlights that are tinted by base color.

Self-Illumination - Mask 1 Channel 4 (A)

No Self-Illumination

Color

Self-Illumination

No Self-Illumination

Color

Self-Illumination
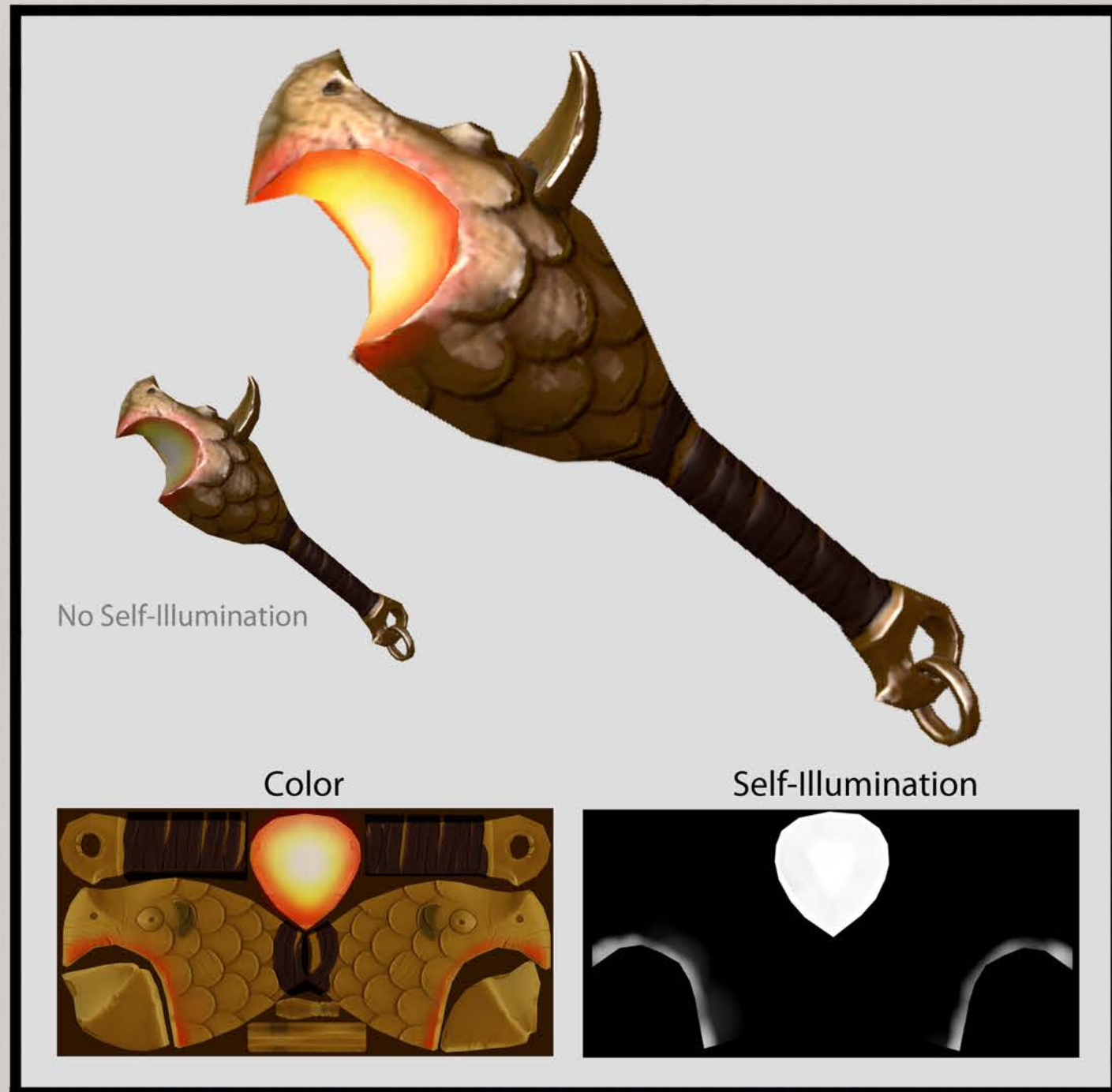
This mask channel can make the pixels of the surface full-bright with the coloring from the color texture. It's used to create glowing areas, such as the mouth of the mace above. A more subtle example would be the bioluminescent organs of Bane (pictured on the right).
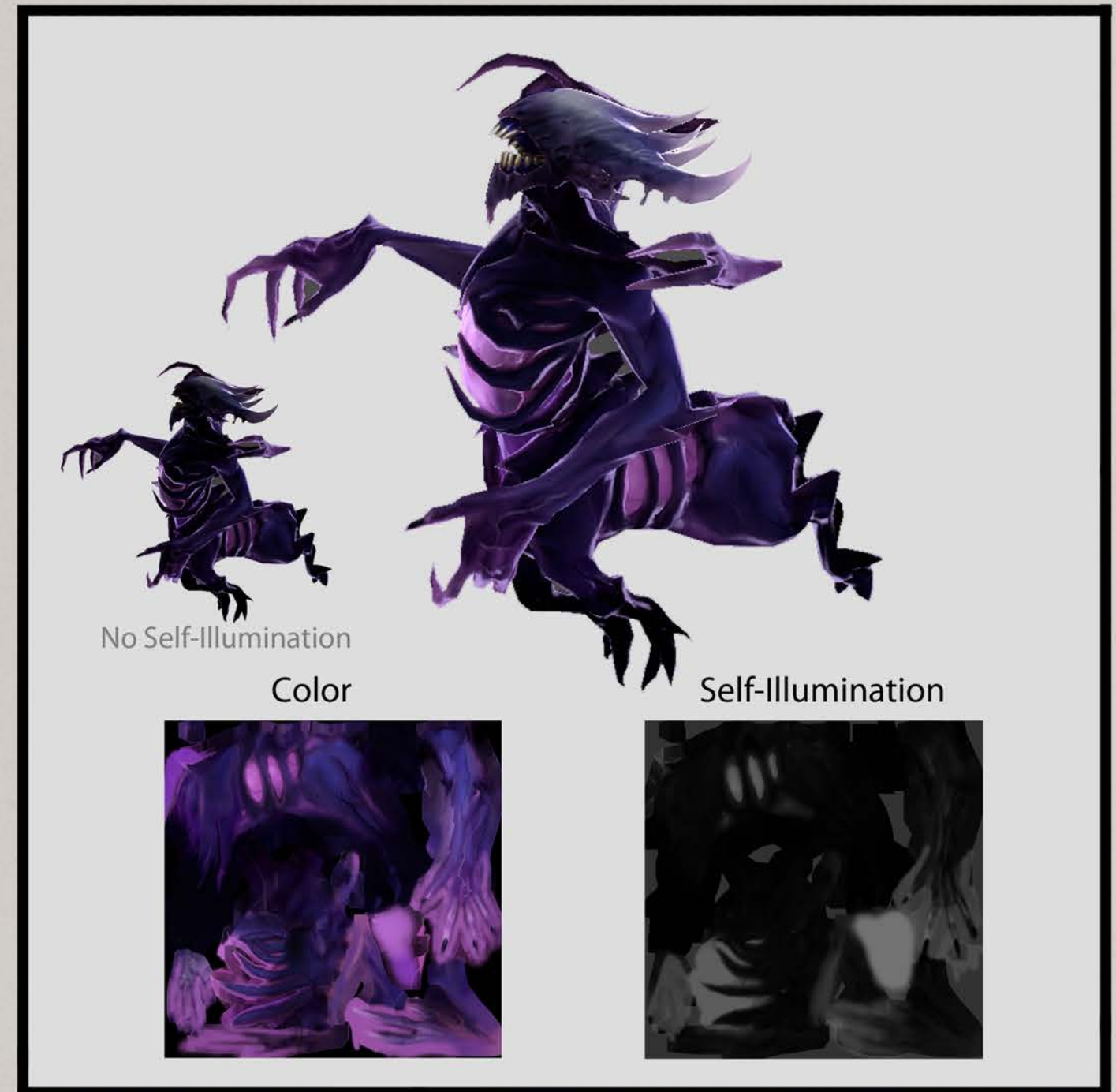
Default values are black. Lighter values will make a surface ignore lighting and just show color texture. Self illuminationed areas in-game will also have a bloom (or glow) effect to them.