

PBR IN GLTF CURRENT STATE

Max Limper & Timo Sturm

Fraunhofer IGD / TU Darmstadt



MOTIVATION

- Physically-Based Rendering (PBR) gets increasingly popular
- glTF 1.0: two ways to define materials
 - Full custom technique / shaders (complex, too general)
 - KHR_materials_common (non-PBR-ready blinn / phong)
- **Aim:** PBR-ready materials in glTF, using most common parameters



COMMON PARAMETER SET CASE STUDY

	Diffuse	NDF (D)	Masking (G)	Fresnel (F)	Roughness (α)	Textures	Specular AA
Frostbite 3	Disney's Model [Burley12]	GGX	Height-Correlated Smith [Heitz14]	Schlick	$\alpha = (1 - \text{Smoothness})^2$	<ul style="list-style-type: none"> Normal BaseColor Smoothness Reflectance Metallic 	None
Unity 5	<ul style="list-style-type: none"> Torrance-Sparrow (PC/consoles) Minimalist Cook-Torrance (Mobile ES 3.0+) Blinn-Phong in RDF form (DX9, ES 2.0) 	<ul style="list-style-type: none"> Blinn-Phong (PC/consoles) Approx. Kelemen (Mobile ES 3.0+) Lookup Texture (DX9, ES 2.0) 	<ul style="list-style-type: none"> Smith (PC/consoles) Szirmay-Kalos (Mobile ES 3.0+) Lookup Texture (DX9, ES 2.0) 	Schlick	$\alpha = 1 - \text{Smoothness}$	<ul style="list-style-type: none"> Albedo (RGB) Specular (RGB) Metallic (R) Smoothness (A) 	None
CryEngine 3	Oren-Nayar [OREN94]	GGX	Schlick-Smith	Schlick	$\alpha = (1 - \text{Smoothness} * 0.7)^{*6}$	<ul style="list-style-type: none"> Normal (RGB) Translucency Luminance/ Prebaked AO Term (A) Diffuse Albedo (RGB) Subsurface Scattering Profile (A) Roughness (R) Specular YCbCr/ Transmittance CbCr (GBA) 	Toksvig
BlackOps 2	Cook-Torrance based	Blinn-Phong	Schlick-Smith	Approx. Schlick $2^{(-10x)} \approx (1-x)^5$	<ul style="list-style-type: none"> $\alpha = 8192^{\wedge}g$ α: specular power g: gloss 	???	None
The Order 1886	Lambert (balanced with specular intensity)	<ul style="list-style-type: none"> GGX Beckmann Anisotropic GGX 	Smith	Schlick	$\alpha = \text{Roughness}$	<ul style="list-style-type: none"> Spherical Gaussian Normals (RG) Diffuse with Alpha (RGBA) Specular with Intensity (RGBA) Roughness (R) AO (G) BRDF Blend (B) Anisotropy (A) 	<ul style="list-style-type: none"> Frequency Domain Normal Map Filtering [Han et al.]
Unreal 4.7	Lambert	GGX	Schlick-Smith	Schlick	$\alpha = \text{Roughness}$	<ul style="list-style-type: none"> BaseColor Metallic Roughness 	Toksvig ???

COMMON PARAMETER SET CASE STUDY

	Diffuse	NDF (D)	Masking (G)	Fresnel (F)	Roughness (α)	Textures	Specular AA
Frostbite 3	Disney's Model [Burley12]	GGX	Height-Correlated Smith [Heitz14]	Schlick	$\alpha = (1 - \text{Smoothness})^2$	<ul style="list-style-type: none"> Normal BaseColor Smoothness Reflectance Metallic 	None
Unity 5	<ul style="list-style-type: none"> Torrance-Sparrow (PC/consoles) Minimalist Cook-Torrance (Mobile ES 3.0+) Blinn-Phong in RDF form (DX9, ES 2.0) 	<ul style="list-style-type: none"> Blinn-Phong (PC/consoles) Approx. Kelemen (Mobile ES 3.0+) Lookup Texture (DX9, ES 2.0) 	<ul style="list-style-type: none"> Smith (PC/consoles) Szirmay-Kalos (Mobile ES 3.0+) Lookup Texture (DX9, ES 2.0) 	Schlick	$\alpha = 1 - \text{Smoothness}$	<ul style="list-style-type: none"> Albedo (RGB) Specular (RGB) Metallic (R) Smoothness (A) 	None
CryEngine 3	Oren-Nayar [OREN94]	GGX	Schlick-Smith	Schlick	$\alpha = (1 - \text{Smoothness})^2$	<ul style="list-style-type: none"> Normal (RGB) Specular (RGB) Transmittance (GBA) 	Toksvig
<p>→ tl;dr: No single common parameter set</p>							
BlackOps 2	Cook-Torrance based	Blinn-Phong	Schlick-Smith	Approx. Schlick $2^{(-10x)} \approx (1-x)^5$	<ul style="list-style-type: none"> $\alpha = 8192^{\alpha g}$ α: specular power g: gloss 	???	None
The Order 1886	Lambert (balanced with specular intensity)	<ul style="list-style-type: none"> GGX Beckmann Anisotropic GGX 	Smith	Schlick	$\alpha = \text{Roughness}$	<ul style="list-style-type: none"> Spherical Gaussian Normals (RG) Diffuse with Alpha (RGBA) Specular with Intensity (RGBA) Roughness (R) AO (G) BRDF Blend (B) Anisotropy (A) 	<ul style="list-style-type: none"> Frequency Domain Normal Map Filtering [Han et al.]
Unreal 4.7	Lambert	GGX	Schlick-Smith	Schlick	$\alpha = \text{Roughness}$	<ul style="list-style-type: none"> BaseColor Metallic Roughness 	Toksvig ???

COMMON PARAMETER SET CASE STUDY

Bad News

- No single common parameter set across engines

Good News

- Frequently used common terms / material properties (Metallic, Specular, Roughness, Smoothness, ...)
- Used shading models are very similar



SHADING MODEL

HOW TO IMPLEMENT PBR?

- Common Model: Microfacet model (Cook-Torrance)
 - Specular (reflected) part via terms D/F/G
- Diffuse part models scattering effects

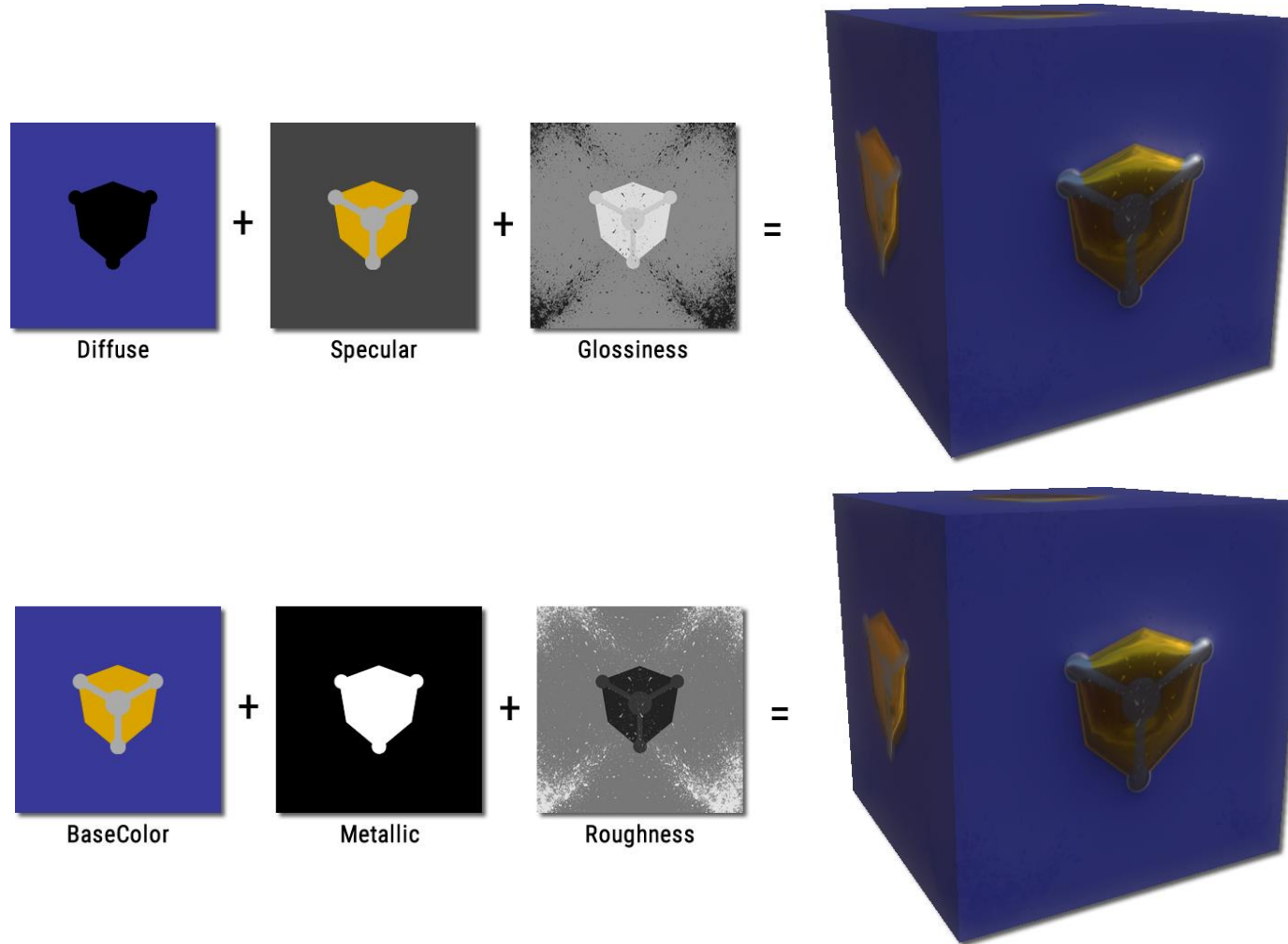
- Various approximations in use
 - Lambert, Oren-Nayar, ... for Diffuse, GGX, Beckmann, ... for Specular D, ...

- **Don't enforce a particular approximation, but provide a useable material parameter set.**



PROPOSAL: TWO PARAMETER SETS

SPECULAR-GLOSSINESS & METAL-ROUGHNESS



GLTF EXTENSION EXAMPLE

```
"materials": {  
  "gold": {  
    "extensions": {  
      „FRAUNHOFER_materials_pbr“ : {  
        "technique" : "PBR_metal_roughness",  
        "values": {  
          "baseColorFactor": [1.00, 0.71, 0.29],  
          "metallicFactor": 1.0,  
          "roughnessFactor": 0.2  
        }  
      }  
    }  
  }  
}
```



GLTF EXTENSION PROPOSAL ON GITHUB



Document / Fork

https://github.com/tsturm/glTF/tree/master/extensions/ Vendor/FRAUNHOFER_materials_pbr

Pull Request

<https://github.com/KhronosGroup/glTF/pull/643>

Our framework

<http://instant3dhub.org>

THANKS FOR YOUR ATTENTION!