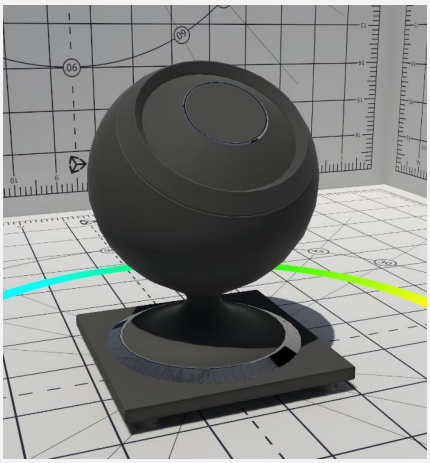
Materials authoring guidelines 1 : dark dielectric materials

Introduction

With the large adoption of Physically Based Shading, game materials parameters changed and replaced diffuse color with Albedo. This parameter represents the characteristic color of an object, and is independent from the lighting conditions. It can be measured and a lot of documents have appeared online, giving reference values for Albedo. Most of them recommend using a range of albedo comprised between 50 and 243 (in 8 bit sRGB).



Issues with the dark materials

This recommended range has been widely spread, but a lot of people have been skeptical about the darkest values allowed by the recommended range. The usual reference values are mostly focused on natural materials, and it appeared that manufactured materials can be darker than natural ones. This has motivated us into making some additional measurements, covering several types of surfaces, and several dark nuances.

Measurements techniques

For our measurements we have used two different techniques :

- Measurements with a Spectrophotometer
- RAW polarized photographs with a macBeth chart

Spectrophotometer

One set of measurement has been acquired using the colormunki photo spectrophotometer. The colormunki photo analyzes a small portion of a flat surface under controlled lighting and gives you the measured color in sRGB and Lab color spaces.

Raw polarized photographs

One set of measurements consists in photographs of the samples and the Xrite color checker taken with homogenous lighting and with a polarizing filter in order to cut part of the specular highlights. Photos have then been linearized with DCraw, exposed and color balanced.

Calibration

For both our techniques, we needed reference values that could validate the calibration of our tools. For that purpose we used a Xrite color checker and the swatches values provided by Xrite as well as the average measurements gathered by ColorBabel.

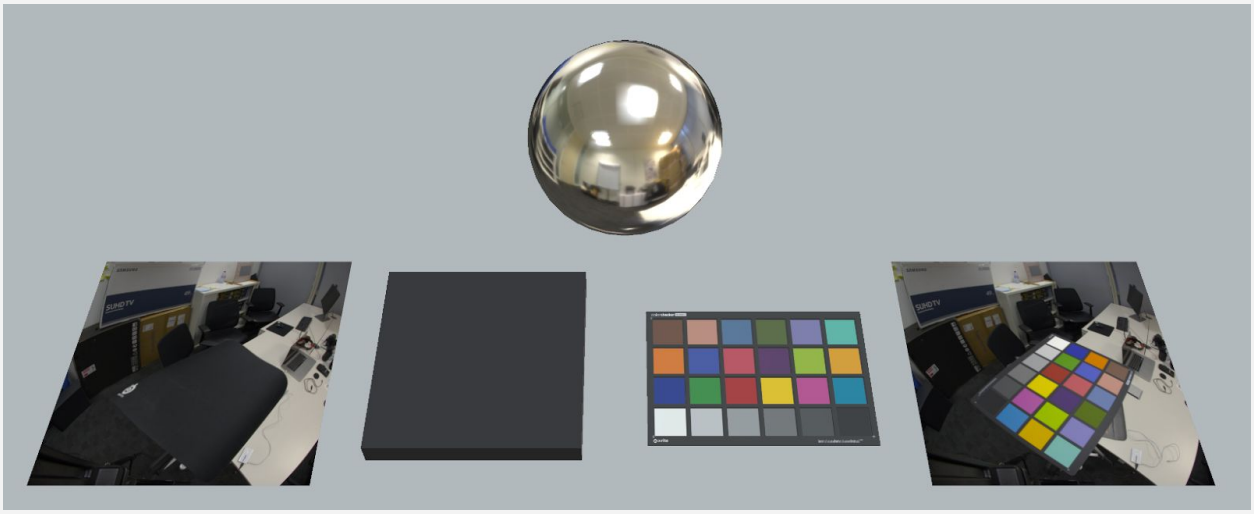
- ➔ The colormunki photo showed a good accuracy in the Lab color space, especially with luminance measurements.
- ➔ RAW photographs of the Xrite color checker linearized with DCraw, then exposed and white balanced according to the 6.5 grey of the Xrite color checker resulted in a captured Xrite color checker with values close to the reference values.

In engine validation

In order to validate our measurements we have captured a 360° HDR image of our office, and then taken HDR pictures of sample objects at the camera location for the 360° image.

Then, in unity, we have lit an object with the 360° HDR image, applied the various measured albedos, and compared the result with the HDR pictures of the sample objects.

The goal was not to observe perfectly matching materials but matching levels of luminosity.



Planes on the left and right are emissive planes using an hdr texture. The box, the color checker, and the chrome ball in the center are 3D objects lit in engine by a 360° hdri captured at the same time and location.

Sample objects : dark manufactured materials

This first document focuses on dark manufactured materials as listed here :

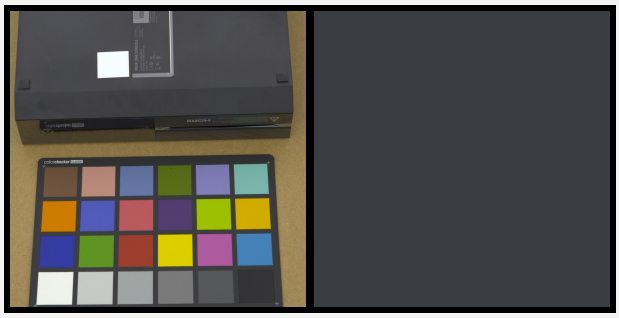
• Black plastic smooth	• Black velvety fabric
• Black plastic rough	• Deep grey pattern carpet floor
• Black rubber rough	• Black printed magazine paper
• Black synthetic fabric	• Deep grey smooth cardboard
• Rough black synthetic fabric	• Black painted wood
• Black dyed cotton	• Black painted metal
• Dark grey dyed cotton	• Black smooth ceramic tile
• Black leather	• Dark grey stone pattern ceramic til

Measurements

Left square is a picture, right square is a color swatch in sRGB 8 bits.

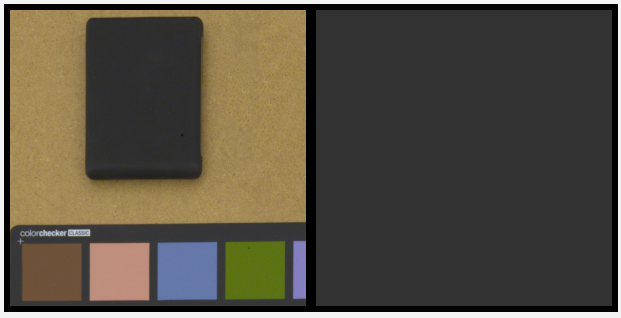
Black plastic smooth

Lab : 12 / -1 / 1
sRGB (8 bits) : 31/ 32 / 31



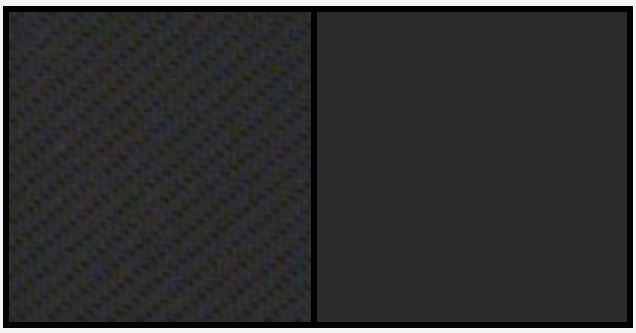
Black plastic rough

Lab : 25.6 / -0.9 / -3.5
sRGB (8 bits) : 58 / 62 / 66



Black rubber rough

Lab : 20.4 / 0.2 / -0.3
sRGB (8 bits) : 50 / 50 / 50

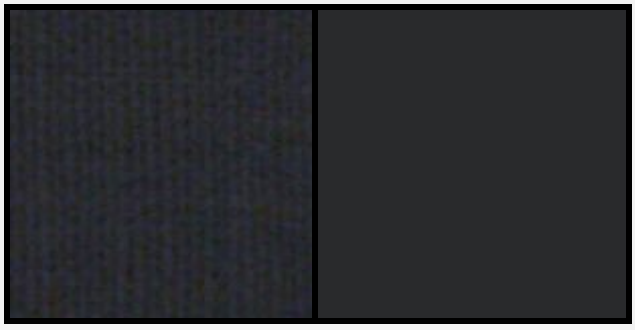


Black synthetic fabric

Lab : 17.5 / 1 / -0.1
sRGB (8 bits) : 44 / 43 / 43

Rough black synthetic fabric

Lab : 15 / 0.9 / -0.1
sRGB (8 bits) : 39 / 38 / 38



Black dyed cotton

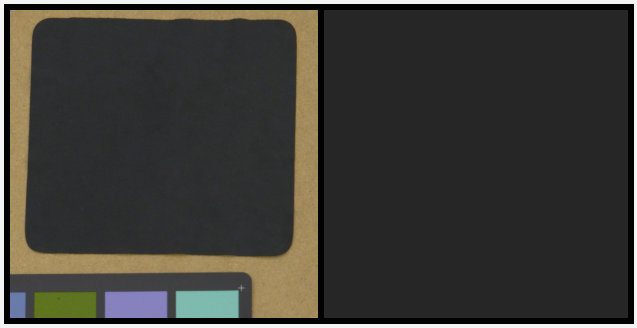
Lab : 16.6 / 1 / -1.9
sRGB (8 bits) : 41 / 42 / 44

Dark grey dyed cotton

Lab : 29 / 1.8 / -2.5
sRGB (8 bits) : 69 / 69 / 73

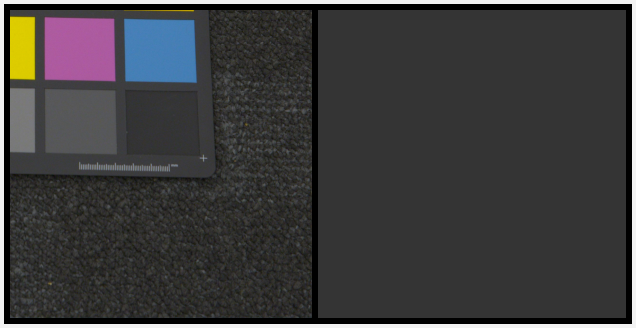
Black leather

Lab : 13.7 / 0.2 / -1.6
sRGB (8 bits) : 35 / 36 / 38



Black velvety fabric

Lab : 14.5 / 1.4 / -0.5
sRGB (8 bits) : 38 / 37 / 38

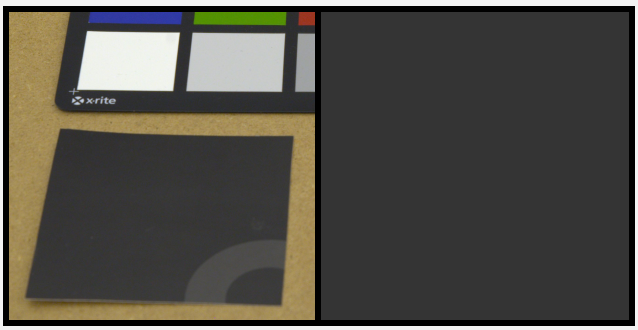


Deep grey pattern carpet floor

Lab : 21.6 / -0.1 / 0.2
sRGB (8 bits) : 52 / 52 / 52

Black printed magazine paper

Lab : 18 / -2 / 2
sRGB (8 bits) : 42 / 44 / 40

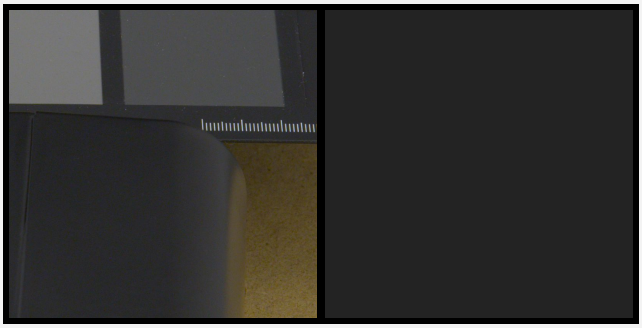


Deep grey smooth cardboard

Lab : 22 / -1 / 0
sRGB (8 bits) : 51 / 52 / 51

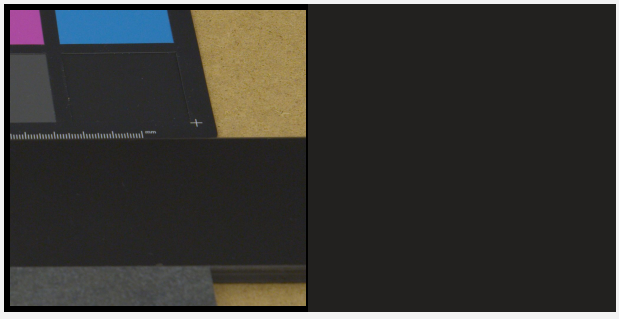
Black painted wood

Lab : 17 / 0 / 0
sRGB (8 bits) : 42 / 43 / 43



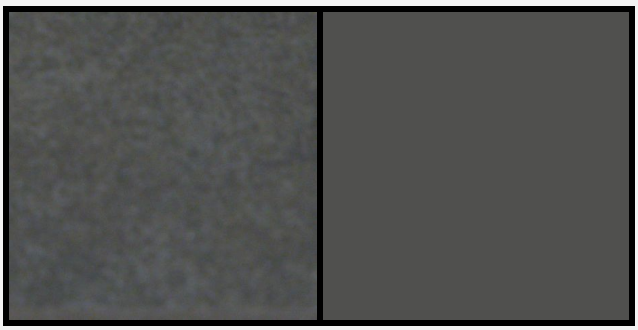
Black painted metal

Lab : 14 / 0 / -1
sRGB (8 bits) : 35 / 35 / 36



Black smooth ceramic tile

Lab : 13 / 1 / 2
sRGB (8 bits) : 35 / 33 / 31



Dark grey stone pattern ceramic tile

Lab : 33.8 / 0 / 0.4
sRGB (8 bits) : 80 / 80 / 79