Creating Digital Twin of Color & Appearance to Reduce Time to Market

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AxF

Has become the industry standard to communicate Color & Appearance

A UNIVERSAL FILE FORMAT THAT OFFERS A STANDARD WAY TO CAPTURE, STORE, EDIT, AND COMMUNICATE COMPLEX COLOR AND APPEARANCE DATA AND META DATA OF A MATERIAL IN ONE SINGLE FILE, ENABLING COMMUNICATION OF HIGHLY ACCURATE, ACHIEVABLE DIGITAL MATERIALS; "**DIGITAL TWINS**"

PANTORA

Total Appearance Eco-System


Development of digital material libraries have:

- Reduced Time to market

- Increased ability to iterate & refine designs

- Leveraged from Design to Marketing

- Saved material & helping sustainability

- Proven to save Cost

PARTNERS SUPPORTING AxF DIGITAL MATERIALS

The Digital Twin of a Physical Material

Design with Confidence and Communicate with Ease
AxF files provide a way to capture, store, edit, and communicate complex material characteristics using numerical data throughout the digital design workflow.
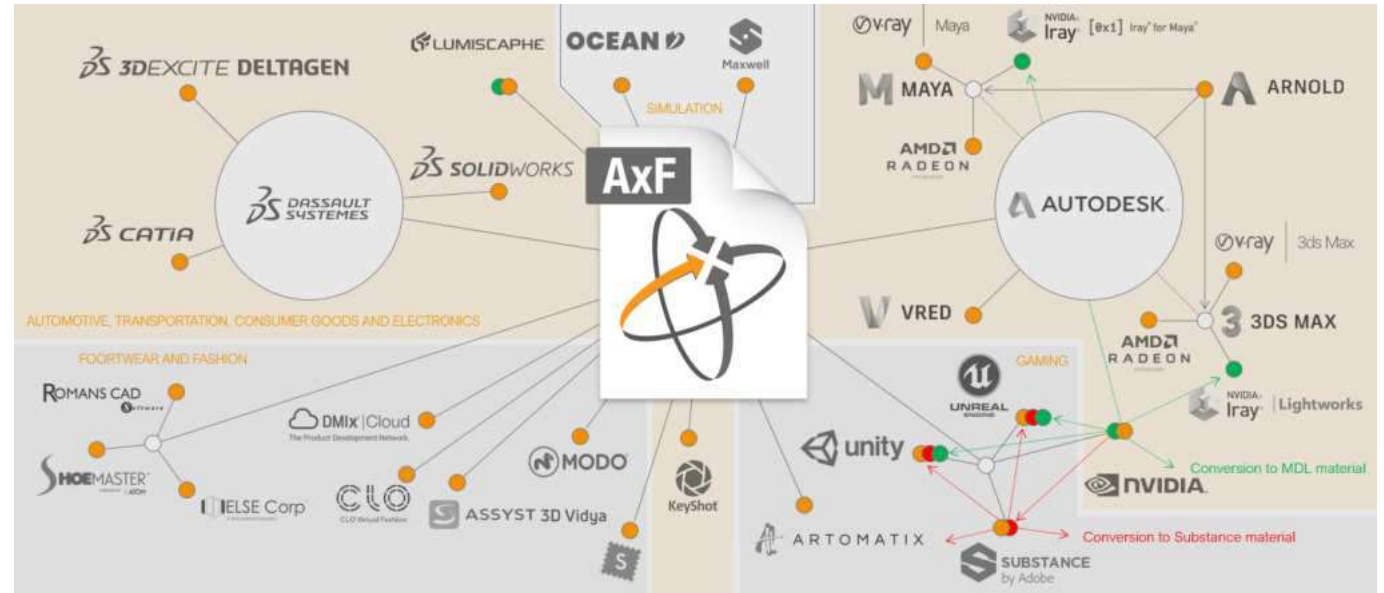
Rivian at Autodesk AIF

Rivian benefits from a digital workflow

Porsche at Autodesk AIF

MA-T12 VS TAC7

X-RITE MA-T12

- Handheld Spectrophotometer
  - 2 pick-ups with 15° & 45°
  - 6 fixed illumination angles
  - 1 RGB Camera at 15°
- High resolution (40 px/mm; 1016 dpi)
- Accurate color based on spectral image measurement
- Correlated gloss measurement
- Well suited for Paints with Effect Pigments
- Optimized for QC purposes (0.18 ΔE2000)

X-RITE TAC7

- Full appearance measurement device
  - Four pick-ups at different altitude angles, rotation stage for up to five azimuth angles
  - 32 b/w + 8 spectral illumination angles, up to 270 additional b/w altitude angles with linear light source
  - 1 backlight illumination angle
- Medium resolution (14.5 px/mm; 385 dpi)
- Accurate color based on spectral image measurement
- True gloss measurement
  - Full range of gloss types from matte to high-gloss surfaces supported
- Precise normal and height maps through structured light projector
- Captures Fresnel effect (IOR) and Anisotropy
- Measured Translucency
- Optimized for Design purposes

COMPARISON BETWEEN THE DIFFERENT SYSTEMS

Dark Green Car Effect Paint

MA-T12 scan
X-Rite SPLQC light booth (D65) virtual environment (D65)

TAC7 scan
X-Rite SPLQC light booth (D65) virtual environment (D65)

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MA-T12 SVBRDF with Pantora 2023.1

Enabling fast capture of a wide variety of materials for Design and Quality Control

Object

Rendered

Expanded capabilities:

- Portable & fast acquisition of multiangle spectral and high-resolution image data.

- Supports workflows for both design and production quality, with close tolerance devices enabling remote virtual assessment.

- Data can be combined with TAC7 and other X-Rite Connect devices within Pantora, providing a scalable solution.

MODELLING LIGHT TRANSPORT

FUNDAMENTALS
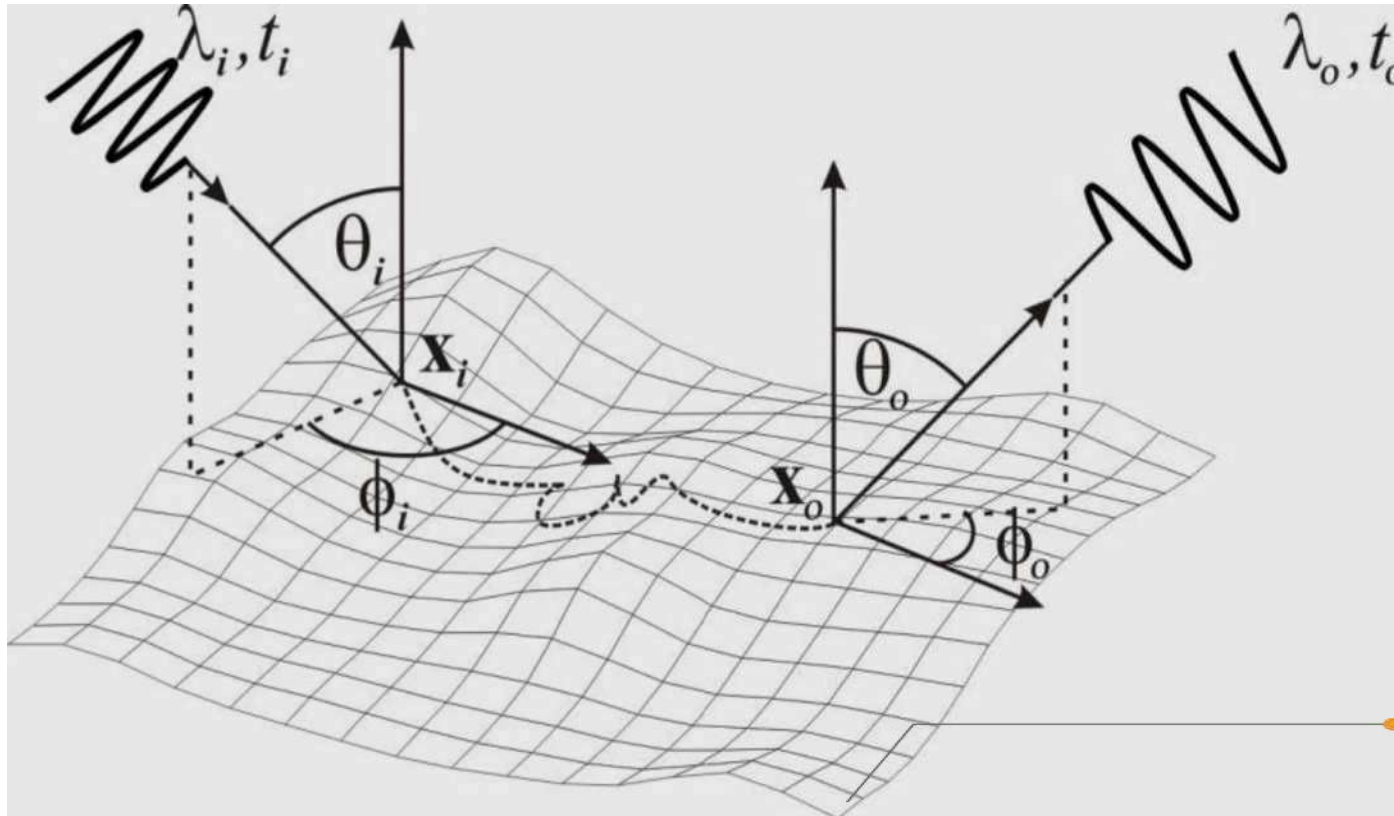
- To describe the appearance of a material it is important to develop a **model that explains how light interacts with an object**.

- **Real-life materials vary in complexity** as they might be composed of different layers with individual optical properties (e.g. a clear coat applied on the surface) or there is a spacial variation of optical properties (e.g. effect pigments distributed in x and y axis).

- **Computer graphics typically use simplified models**, which ignore certain optical phenomena because they are either difficult to determine or they increase computational effort significantly.

THIS GRAPH SHOWS A SIMPLIFIED MODEL OF LIGHT MATTER INTERACTION WHİCH EXPLAINS EFFECTS LIKE 1ST SURFACE REFLECTION (GLOSS), ABSORPTION AND SUB-SURFACE SCATTERING (SSS).

MATRIX

Measurement Capabilities

	Ci7800	META VUE	MA-T12	TAC7
Spectral Measurement & Workflow	🟢	🟢	🟢	🔴
Diffuse Color	🟡	🟢	🟢	🟢
Normal	🔴	🟢	🟡	🟢
Specular Color	🟡	🟡	🟢	🟢
Roughness	🔴	🟡	🟢	🟢
Height Information	🔴	🔴	🔴	🟢
Anisotropy	🔴	🔴	🔴	🟢
Fresnel	🔴	🔴	🔴	🟢
Transparency	🟢	🔴	🔴	🟢
Volumetric Scattering	🟢	🔴	🔴	🟢
CarPaint with Effect Pigments	🔴	🔴	🟢	🟢
Orange Peel / DOI	🔴	🔴	🔴	🟢
Colored / Tinted Clear Coat	🟡	🔴	🔴	🟢

🔴 Not Supported   🟡 Limited (Spot)   🟢 Supported

x·rite PANTONE®

MATRIX

Measurement Capabilities

	Car Refinish / Paint	Plastics	Textile	Leather	Metal
Diffuse Color	🔴	🟢	🟢	🟢	🟢
Normal	🔴	🟢	🟢	🟢	🟢
Specular Color	🔴	🟢	🟢	🟢	🟢
Roughness	🔴	🟢	🟢	🟢	🟢
Height Information	🔴	🟢	🟢	🟢	🟢
Anisotropy	🔴	🔴	🟢	🔴	🟡
Fresnel	🔴	🟡	🟢	🟢	🟢
Transparency	🔴	🟢	🟢	🟢	🔴
Volumetric Scattering	🔴	🟢	🔴	🔴	🔴
CarPaint with Effect Pigments	🟢	🔴	🔴	🔴	🔴
Orange Peel / DOI	🟢	🔴	🔴	🔴	🔴
Colored / Tinted Clear Coat	🟢	🔴	🔴	🔴	🔴

🔴 Not Supported   🟡 Limited   🟢 Supported

x·rite **PANTONE®**
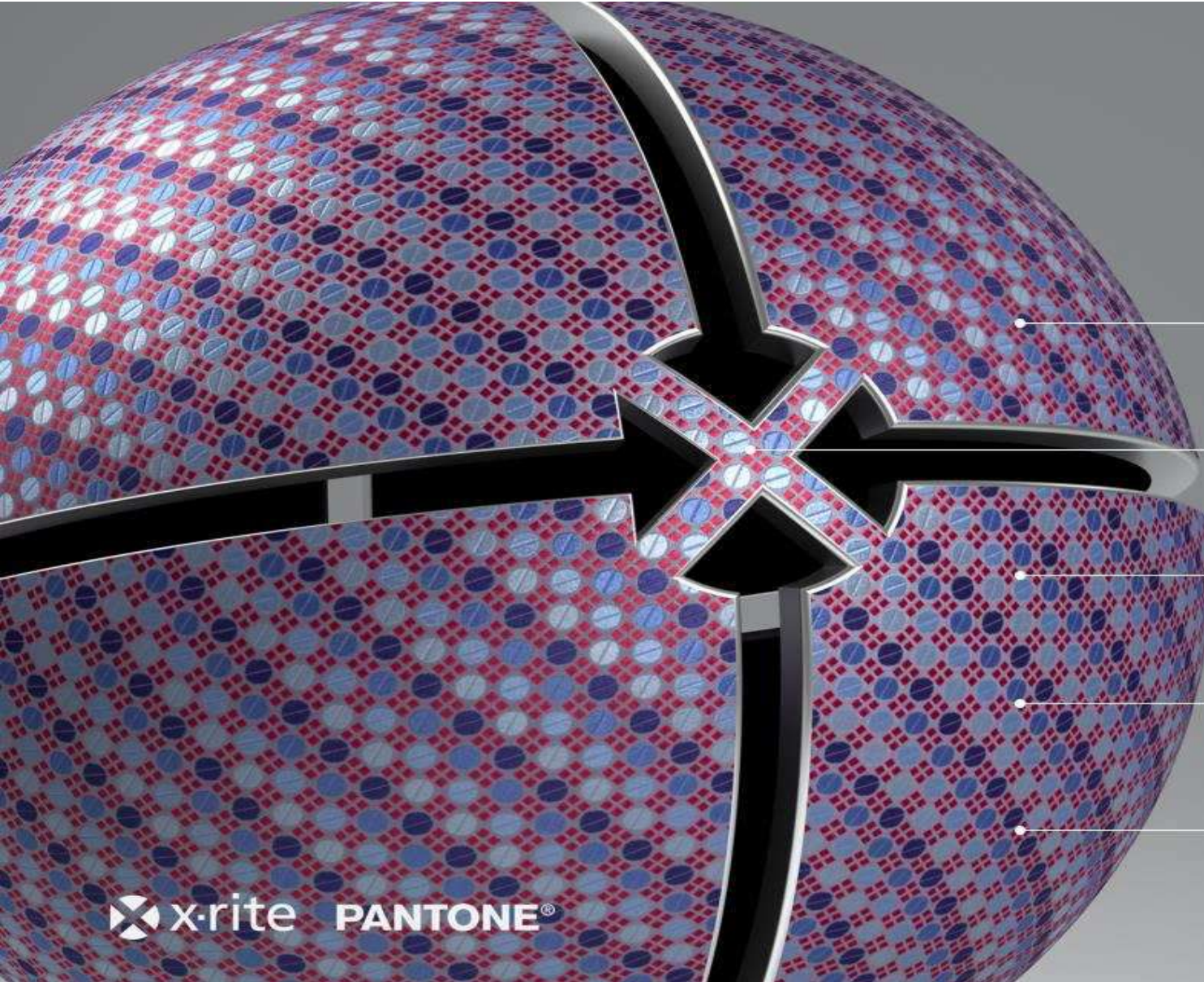
REPRESENTATION CLASSES | SVBRDF

ISOTROPIC VS. ANISOTROPIC MATERIALS

Some materials like brushed metals or woven fabrics show a directionally dependent behavior for gloss and color. They will look different when rotated by 90°. Such a behavior is called **anisotropy** and can be stored in the anisotropic rotation map.

Diffuse Color Map
Body color of the material (albedo)

Specular Color Map
Color of the specular highlight
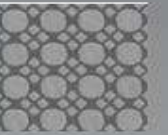
Normal Map
Orientation of the surface normal

Roughness (iso- or anisotropic) Map
Defining spatially varying gloss

Anisotropic Rotation Map
Rotation angle of the specular highlight

REPRESENTATION CLASSES | CPA2
THE MODEL FOR PAINT AND COATINGS

Since metallic paints – as they are typically used in automotive industry – are not well represented by either SVBRDFs or standard BTFs AxF supports a specialized representation for measured paints called CPA.

The model for the opaque base paint layer consists of three main parameters:

Flake BTF Textures
captures the visible
Flakes of the paint

Color table
captures low-frequency
color travel of the paint

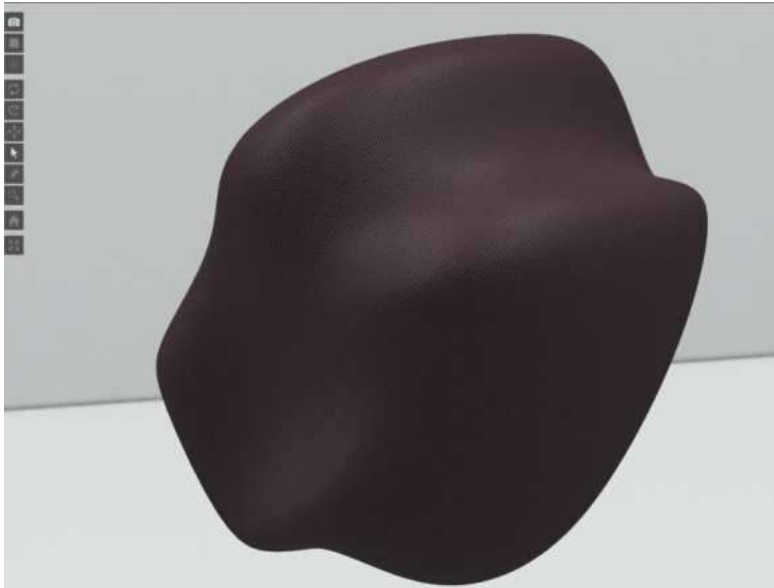**Brightness BRDF**
captures the angular brightness
variation of the paint

PANTORA 2023.2 Update

Improved Color Accuracy

- Some materials have a strong response in the infrared band, that the MA-T12 camera does not fully filter out
- Correction in Pantora now provides accurate color on these material types
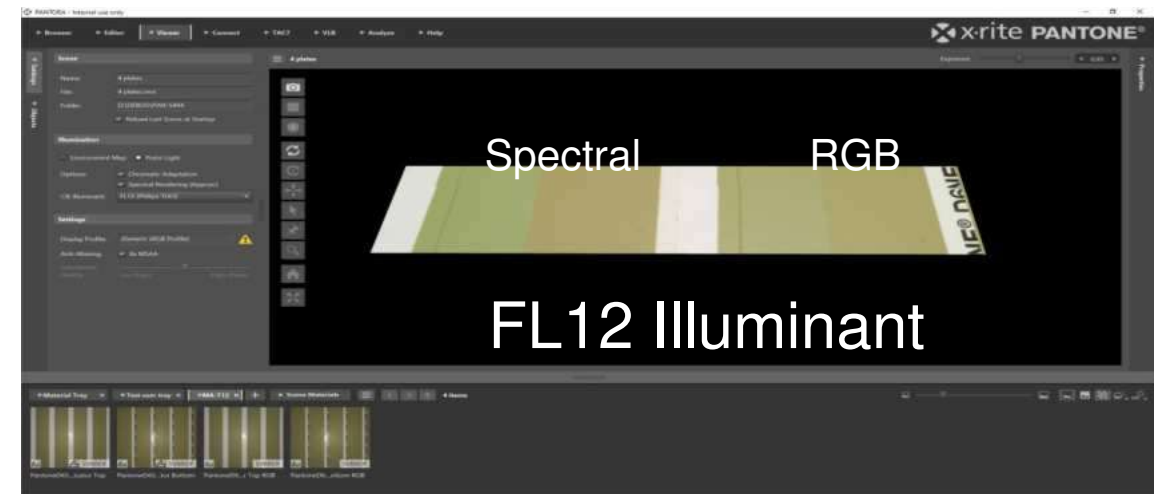

Previous Versions

Pantora 2023.2

Spectralization

- MA-T12 outputs images in calibrated RGB
- Pantora now combines RGB images with spectral measurements to "spectralize" images and create spectral SVBRDF
- Improved color rendering under different light conditions

Improved rendering performance

- New MA-T12 firmware switches off "high-pass filter" improving SVBRDF
- High-pass filter caused structures in image along high contrast edges
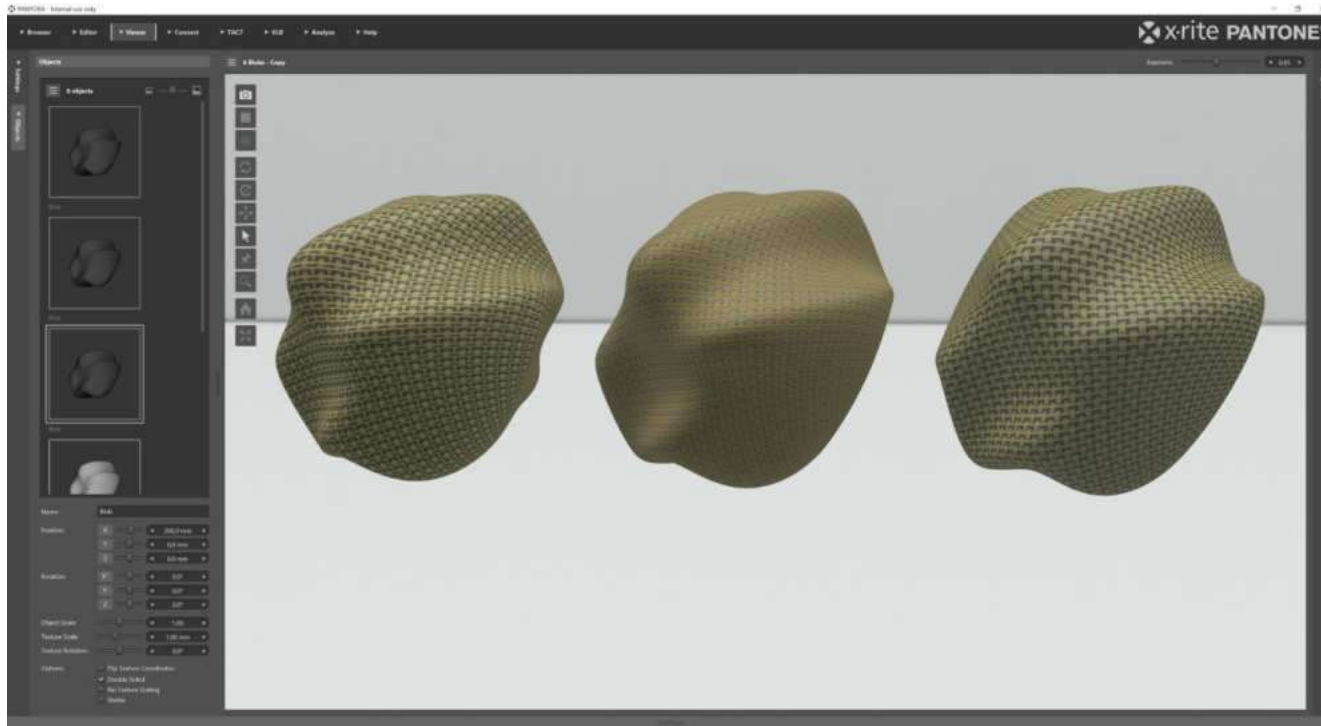
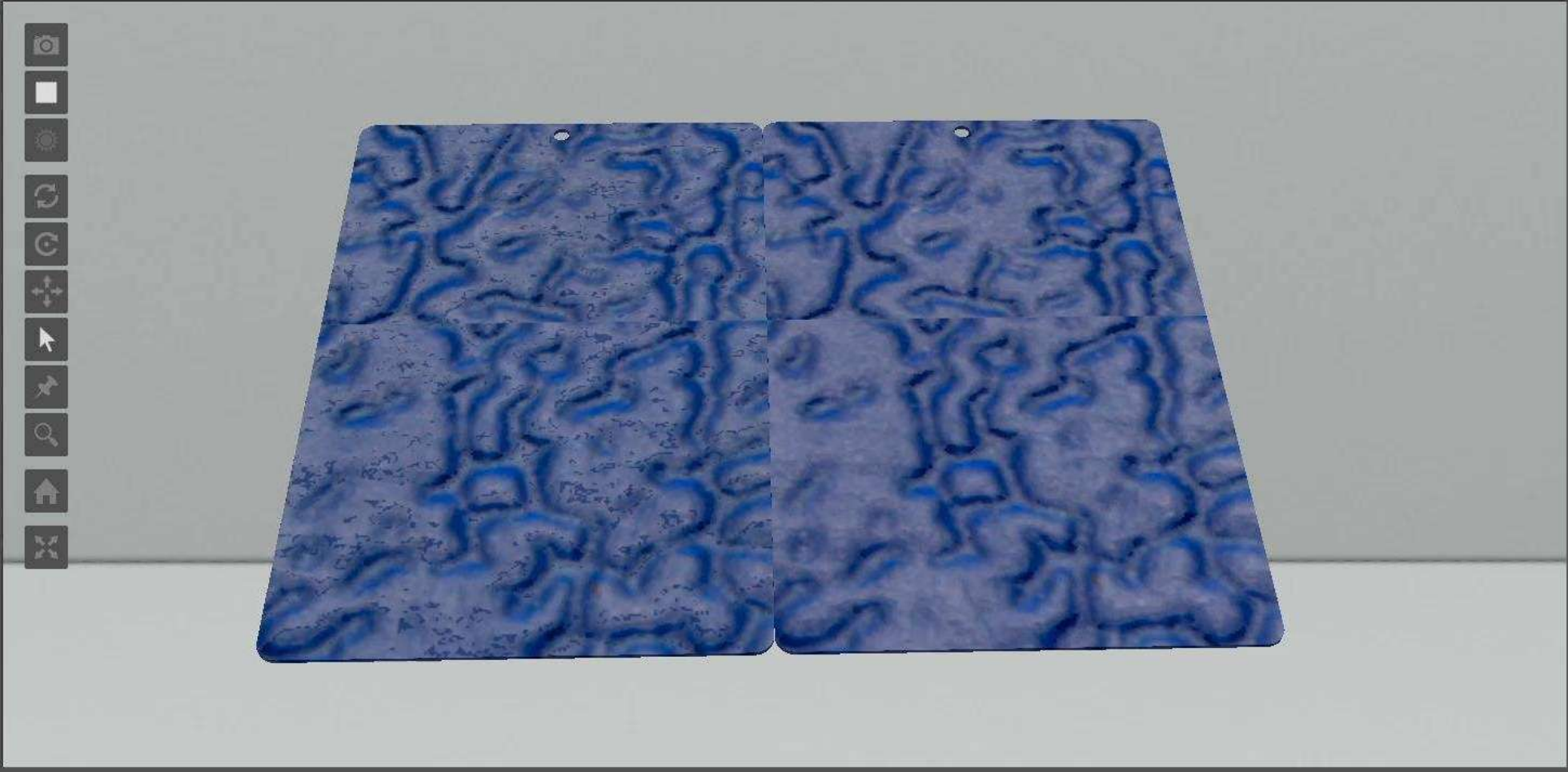*Please note:
MetaVue and MA-T12
measurements captured
a different ROI which explains
the different tiling. Appearance
and color are quite similar

► Browser ► Editor ▼ Viewer ► Connect ► TAC7 ► VLB ► Analyze ► Help

x·rite **PANTONE**

Scene

≡ Plastic flat green 2 panel

Exposure: ◄ 0.77 ►

00:00

► Material Tray ✕ ▼ User Tray ✕ ► MetaVue ✕ ► COY 2022 ✕ + ► Scene Materials ≡ ◄ ► ↑ 100 items

2blue textile | plastic ...se green | plastic fine green | desk | phone | case inside | svbrdf | Extreme | carb weave | knoll | effect green | effect green clear | effect circle | tape gun blue | metal knife | ipad tex...one blue

SVBRDF | SVBRDF | SVBRDF | SVBRDF

pre hi | pre tex | pre plas | post plas

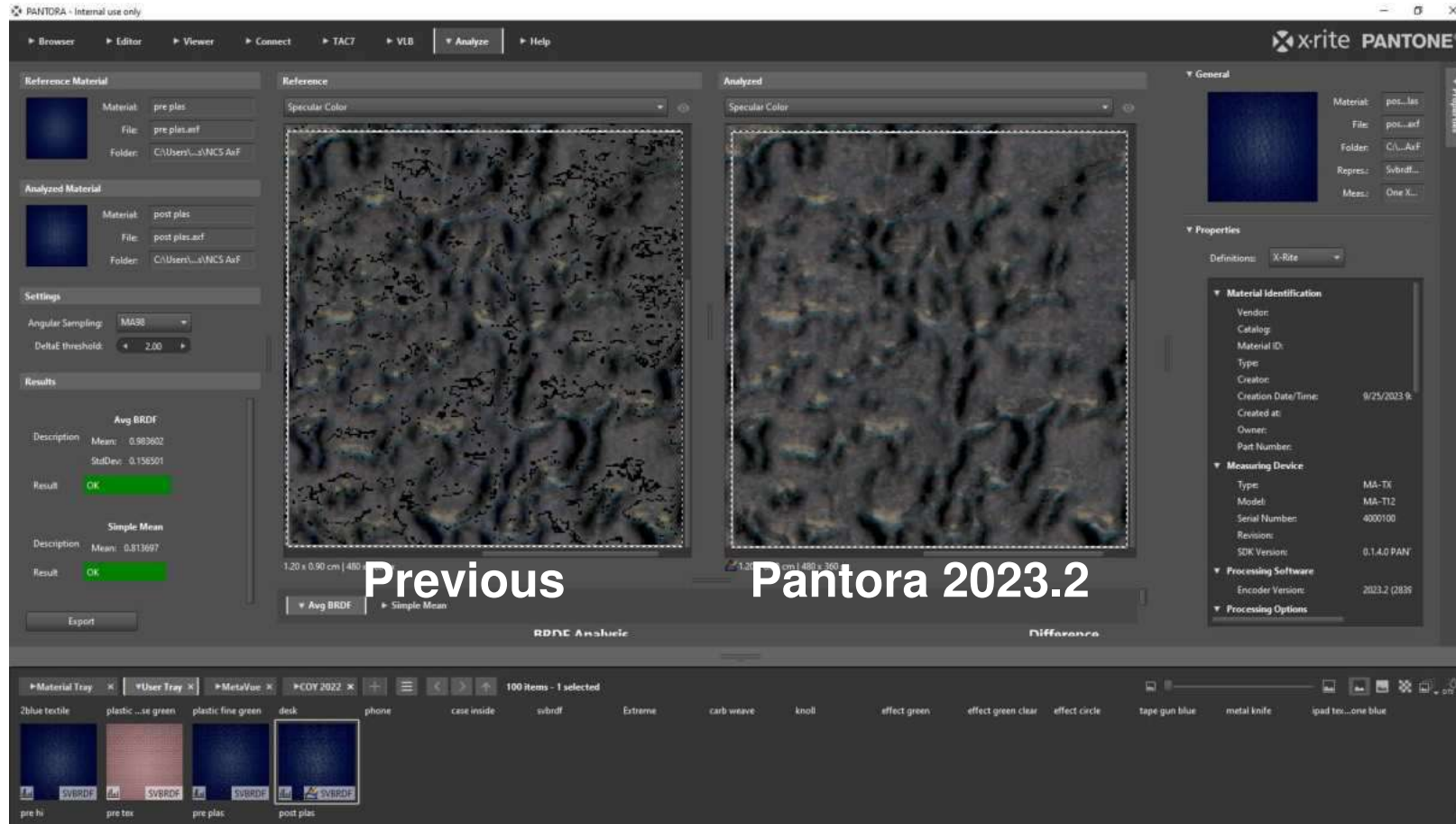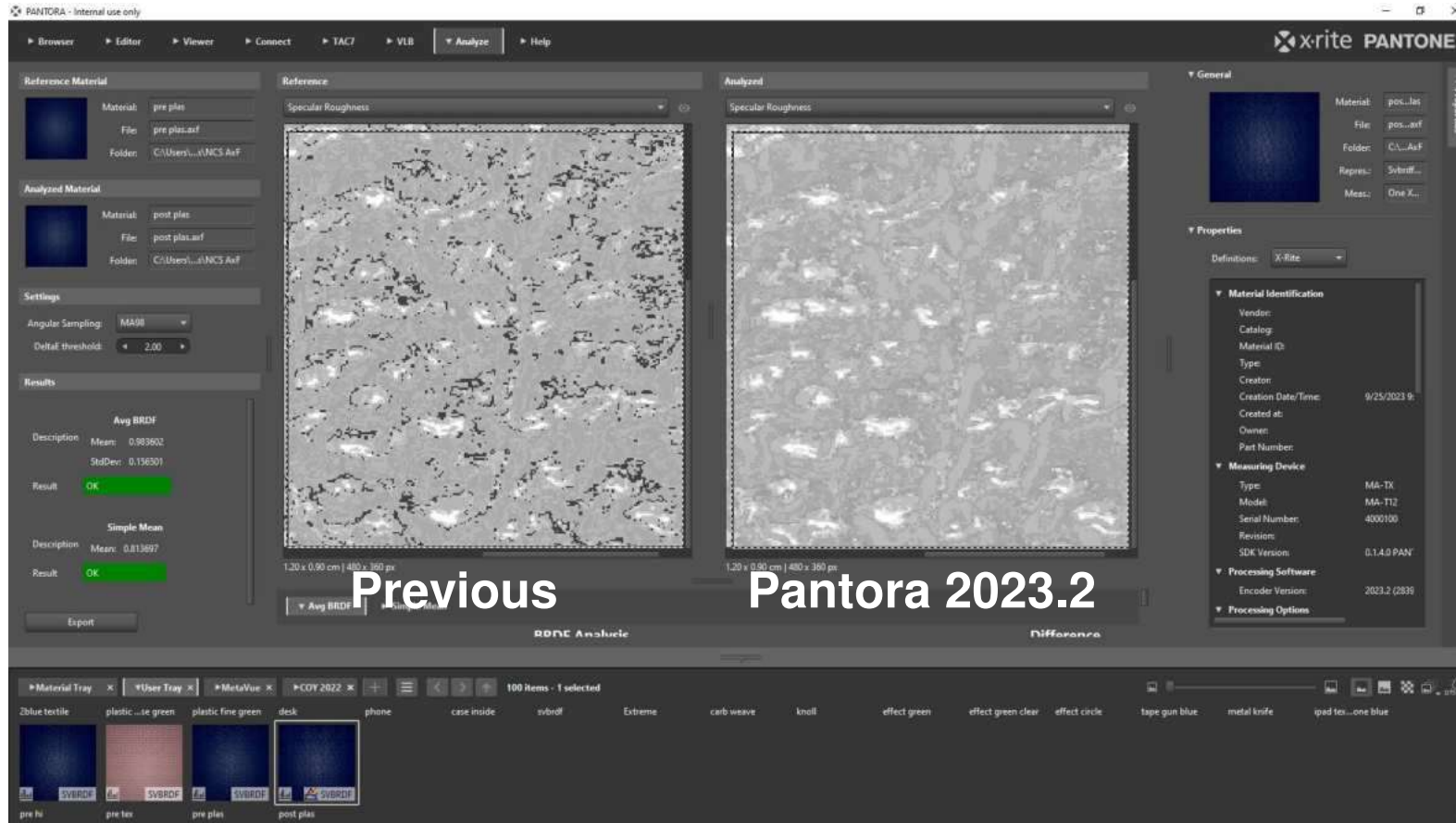# Closeup of Blue Sample
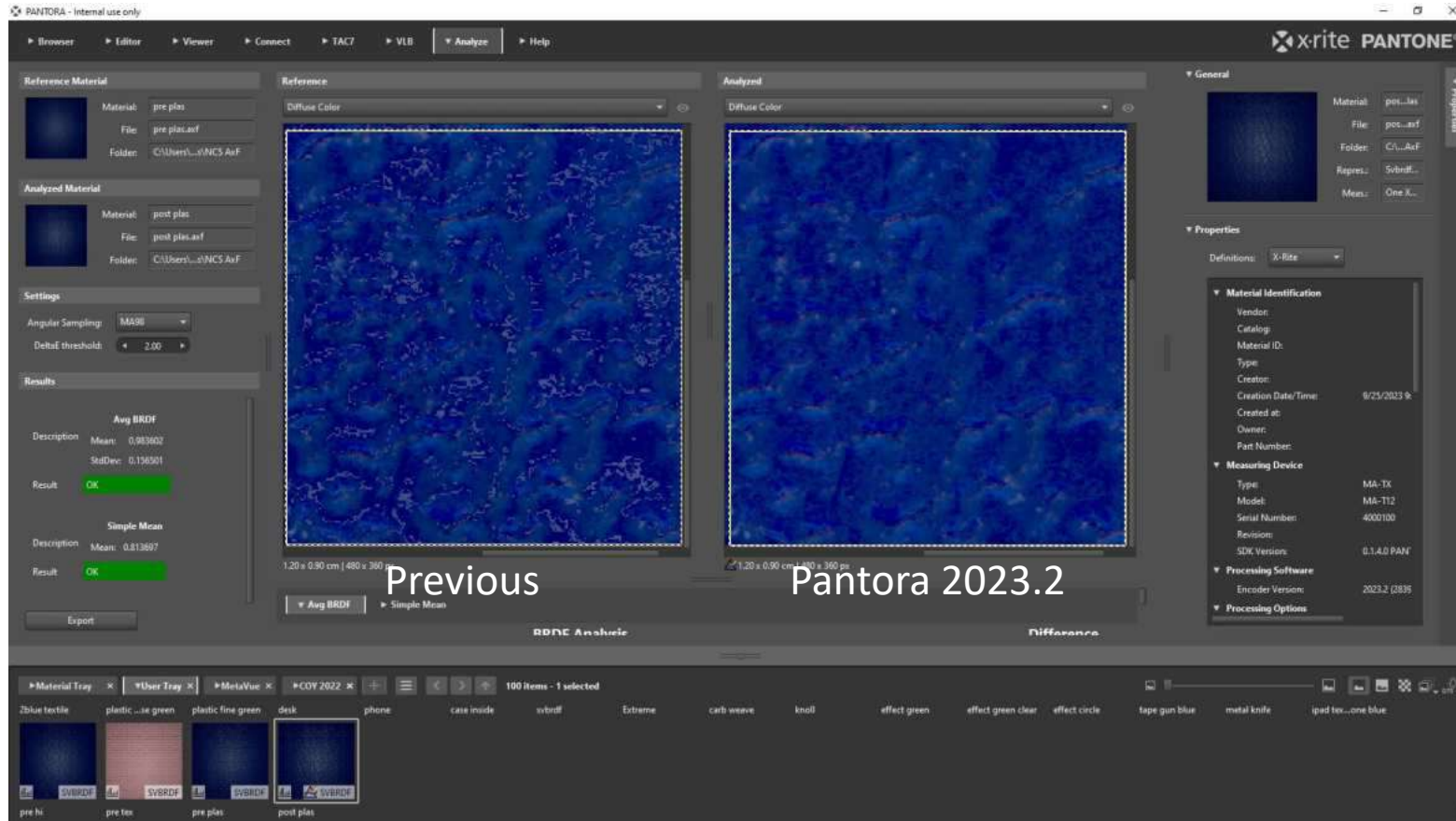
Closeup of Blue Sample
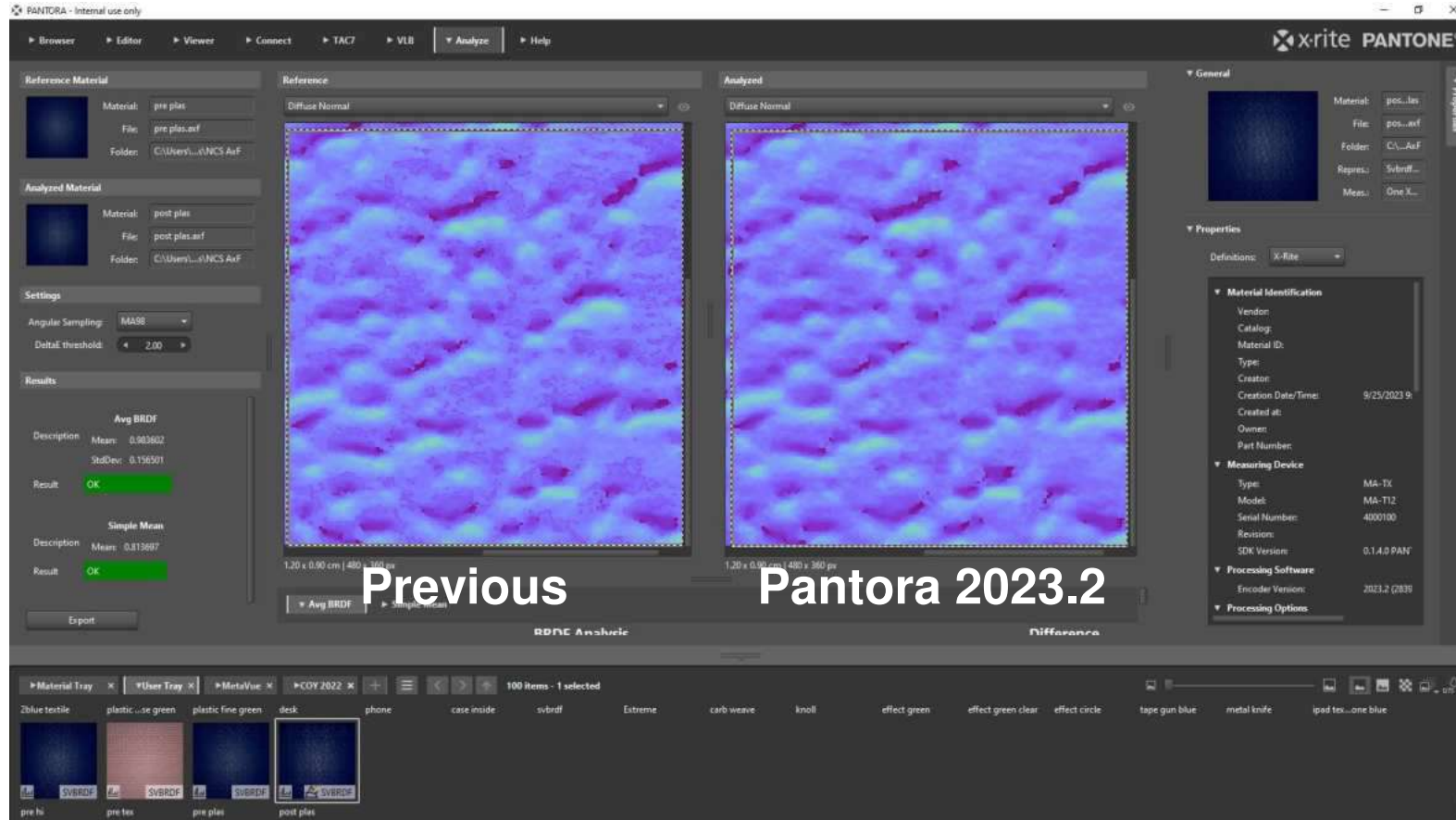
Closeup of Black Sample

Previous   Pantora 2023.2

Closeup of Grey Sample