



Spectral Library

OF ROOFTOP URBAN MATERIALS

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Sostenipra Research Group



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Preface

This spectral library of rooftop urban materials (SLyRUM), provides spectral signatures and reflectance data for rooftop materials from the Mediterranean region. The SLyRUM, has been developed as a result of a study whose main objective was to develop a methodology to obtain spectral signatures. Measurements were performed at laboratory-level, in the Hyperspectral Laboratory of the Cartographic and Geological Institute of Catalonia (ICGC), through a contract with the Universitat Politècnica de Catalunya and with the collaboration of the Universitat Autònoma de Barcelona. The SLyRUM is part of the **Fertilecity® II** project, funded by the *Ministry of Economy and Competitiveness* (MINECO) (CTM2016-75772-C3-3-R, AEI/FEDER, UE).

The objective of **Fertilecity® II** project (2017-2019) is deepening on research of urban agriculture in rooftop greenhouses (RTGs) integrated with the supporting building and providing information and tools that make such integrated RTGs possible. During **Fertilecity® I** project, a new facility started to operate on the Institute of Environmental Sciences and Technology building roof. In 2014-2016 different lettuce and tomatoes crops were grown. Such facility was connected to the building in terms of water, energy and CO₂, but only one-way, from the building to the green house.

Fertilecity® II project focuses on establishing a two-way greenhouse building connection. The project addresses subjects such as the recirculation of water of agricultural production; detailed energy modelling of the greenhouse building system and its comparison with conventional greenhouses; the architectural and constructive study on a building and at neighborhood scale; and the identification of business models.

For more Information about **Fertilecity®** projects visit the website www.fertilecity.com

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Introduction

Rapid urbanization, increase population and migration from rural to urban areas, brings degradation and environmental impacts. An increased pressure on natural areas is one of the negative impacts of this worldwide urbanization process. To supply essential needs such as food, water and energy; cities have to depend on outlying regions making cities unsustainable. According to the United Nations (2014), 66% of the world's population will live in urban areas by 2050. As a consequence, cities will demand more resources such as water and food. In this context, cities have to improve resource management through sustainable urban planning strategies. In the last years, rooftops have emerged as a potential spaces to produce resources, such as water, food and energy. Converting empty spaces into productive spaces in cities, reducing environmental impacts and contributing to sustainable strategies. In this regard, data of rooftop materials are required to support the decision-making process in sustainable urban planning. This spectral library was developed with the aim to contribute to the knowledge of spectral characteristics of rooftop materials in the Mediterranean region. The SLyRUM is divided into 6 sections according to material classes (Table 1).

Rooftop materials

The selection of materials was determined by identifying typical rooftop building materials in the Mediterranean region and taking into account the lack of knowledge regarding some materials such as metals and plastics. The materials were grouped into classes. Most of the sample materials were artificial. However, granites, slate and wood were also included, as they are common (especially on rooftop terraces) rooftop materials. Various material colors were considered in the sample selection. For material identification, each sample was coded with a word identifying the material class in addition to an ID number.

Table 1. Material class and number of samples studies

Material class	Code sample	Number of samples
Ceramic	C	5
Concrete/ Cement	T	4
Metals	M	9
Plastics	P	11
Stone	S	7
Wood	W	3

Methodology

Laboratory measurements were conducted using a Hyperspectral Remote Sensing (AISA-EAGLE 2). A total of 39 samples of typical rooftop materials from the Mediterranean region were analyzed. A software program written in Python was developed for processing data radiance and obtain spectral signatures. The spectral library includes the spectral signatures at four different angles (0° , 5° , 10° and 15°) for each material.

Figure 1 illustrates a summary of the three general stages of the proposed methodology for spectral reflectance data collection for urban rooftop materials. Stage 1: *data acquisition* at the laboratory level using hyperspectral remote sensing. Stage 2: *data processing* using Geo View 2 software and a software program developed to obtain spectral signatures. Stage 3: *spectral library creation*.

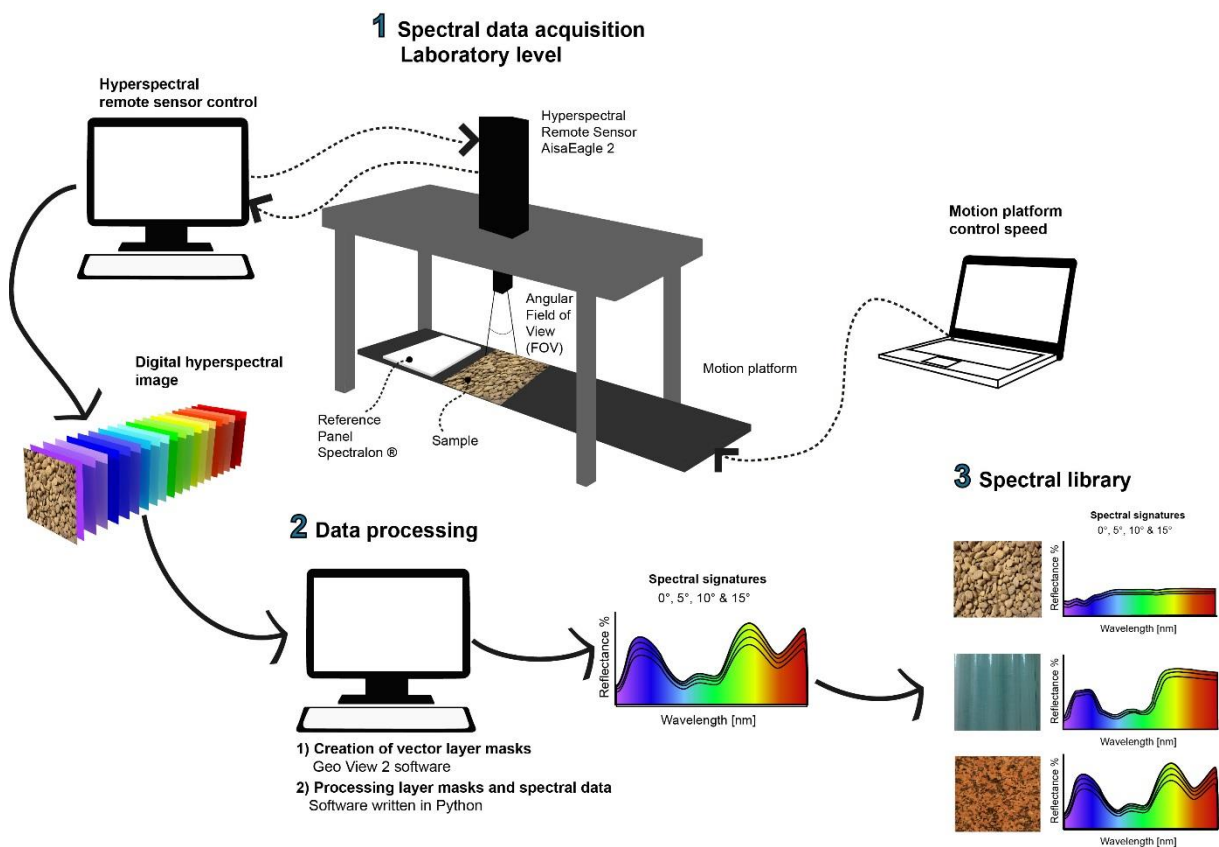
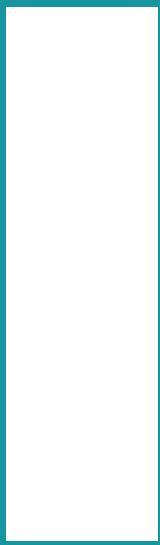


Fig. 1 Graphical representation of the three general stages of the methodology to obtain VNIR spectral signatures and the spectral library

The ID classification is shown at the top along with general information about the sample, there is a photograph of the sample with a metal ruler (15 cm) for visual reference. Finally, the VNIR spectral signature is presented.

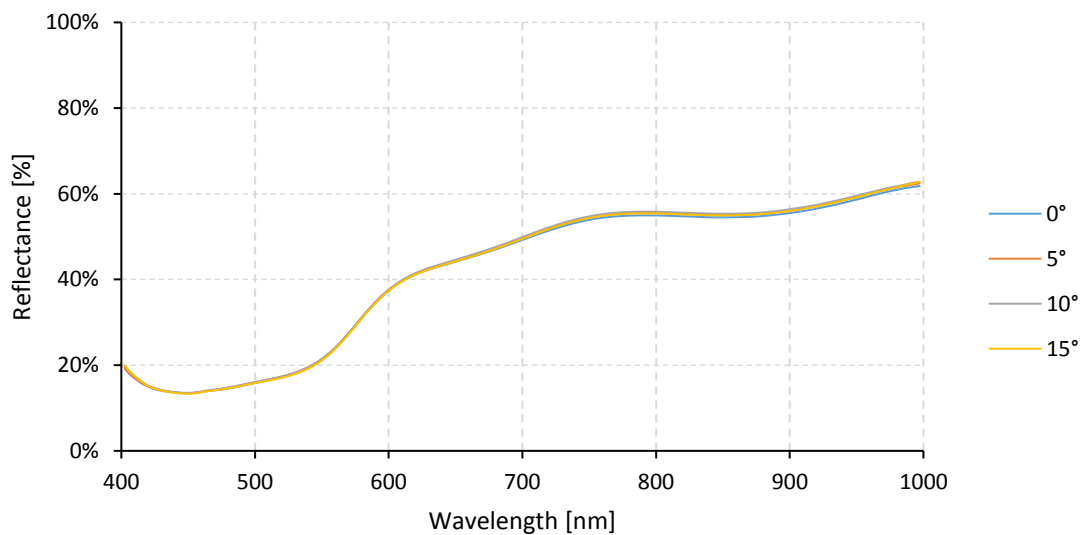
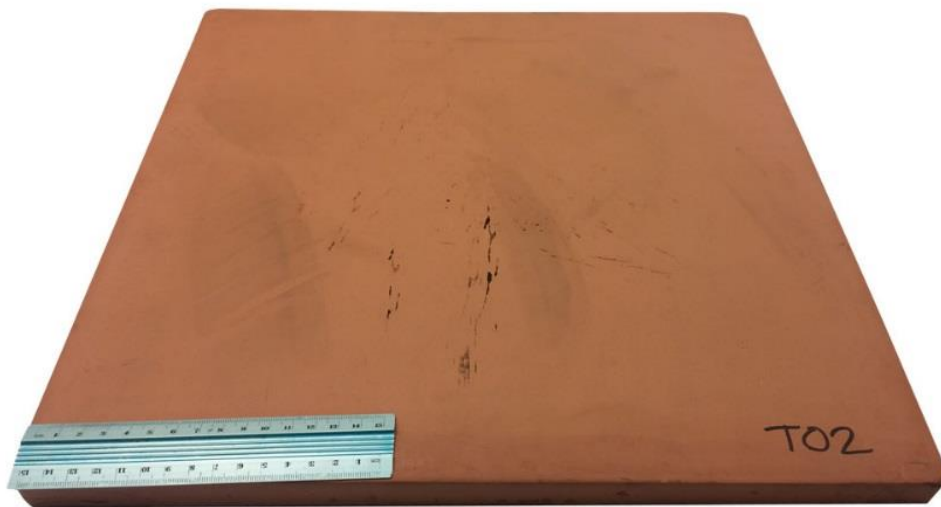
MATERIAL CLASS SAMPLE ID	
Class	
Material	
Color	
Status	
Dimension [mm]	
<p>Photograph of the sample material</p>	
<p>VNIR Spectral Signature</p>	



Ceramic

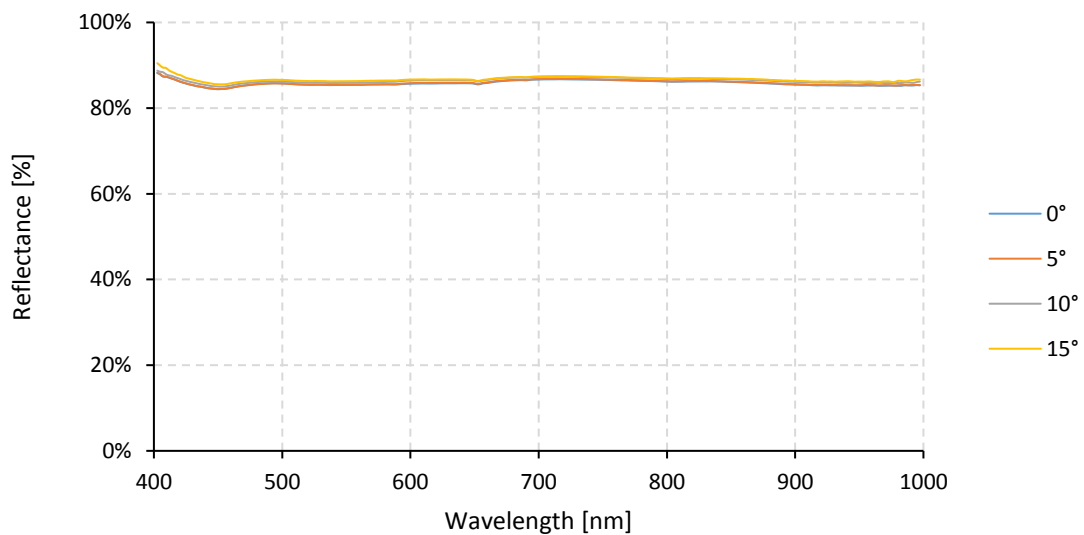
Ceramic C01

Class	Ceramic
Material	Ceramic tile
Color	Burnt red, dull
Status	New
Dimension [mm]	400 x 400 x 20



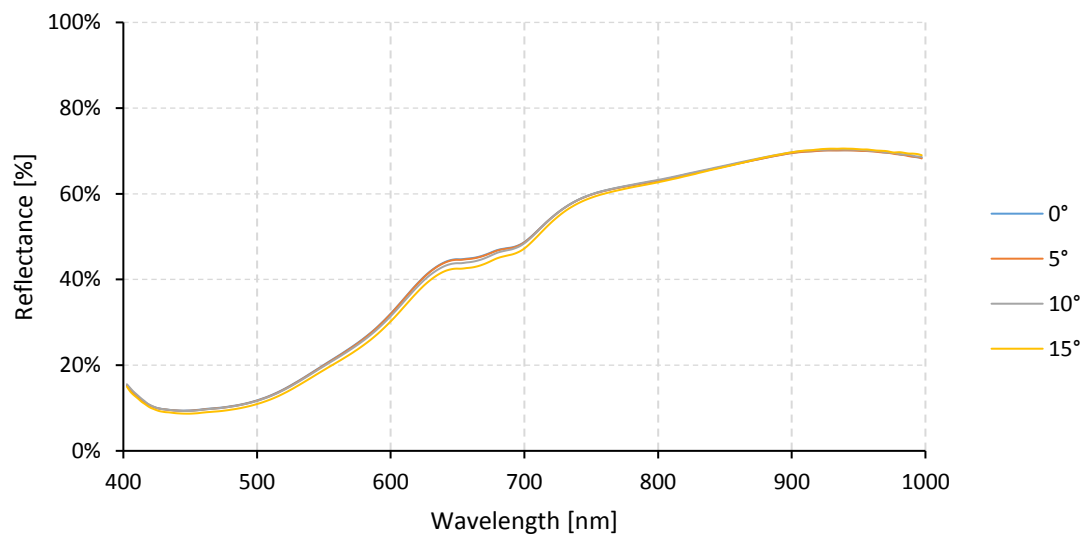
Ceramic C02

Class	Ceramic
Material	Gres porcelain tile
Color	White, shiny
Status	New
Dimension [mm]	300 x 600 x 6



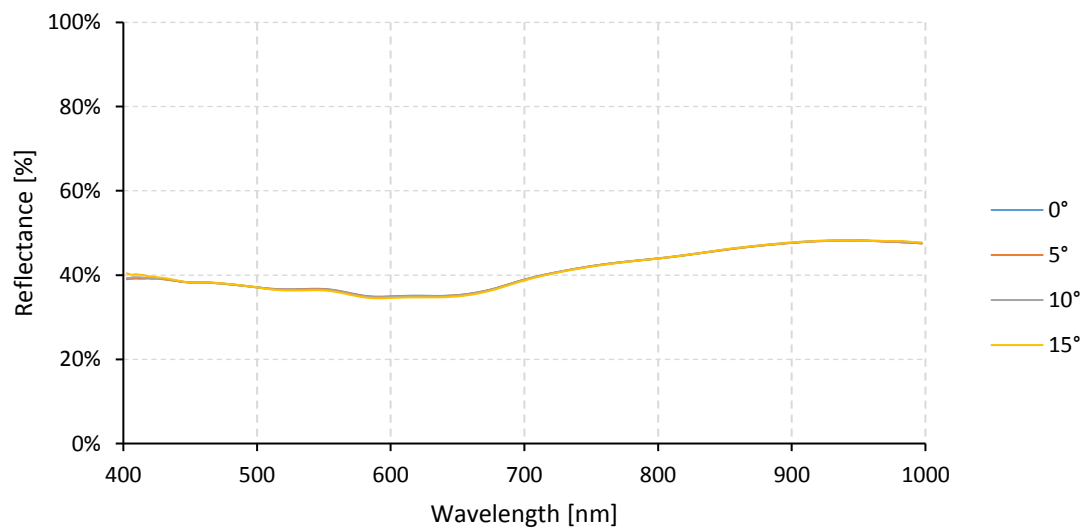
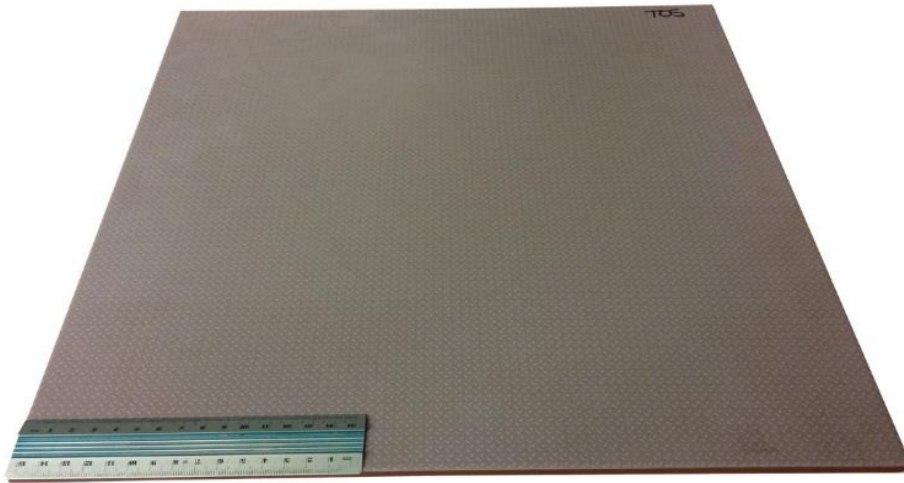
Ceramic C03

Class	Ceramic
Material	Gres porcelain tile
Color	Red
Status	New
Dimension [mm]	300 x 600 x 6



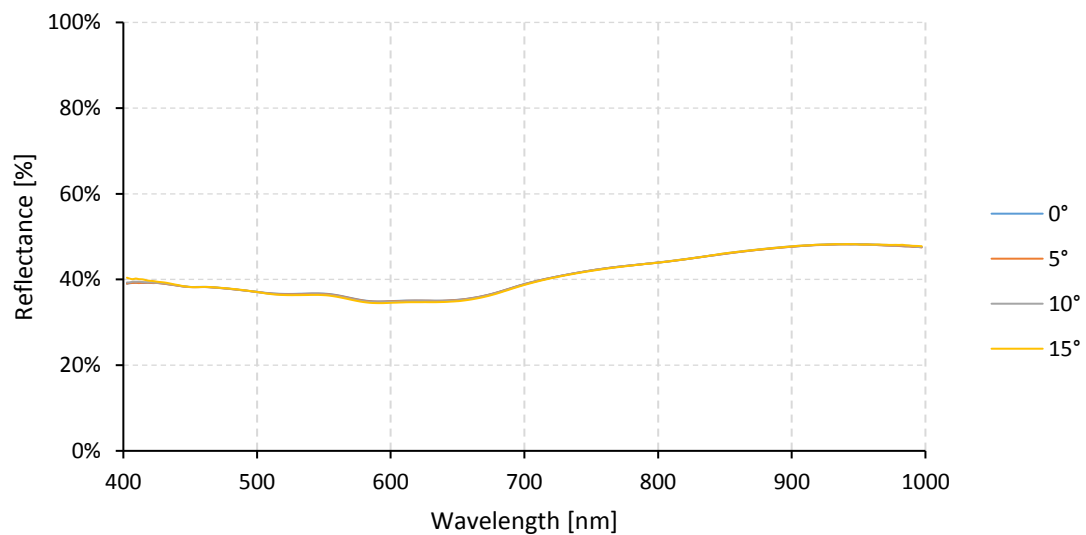
Ceramic C04

Class	Ceramic
Material	Gres porcelain tile
Color	Gray, dull
Status	New
Dimension [mm]	410 x 410 x 5



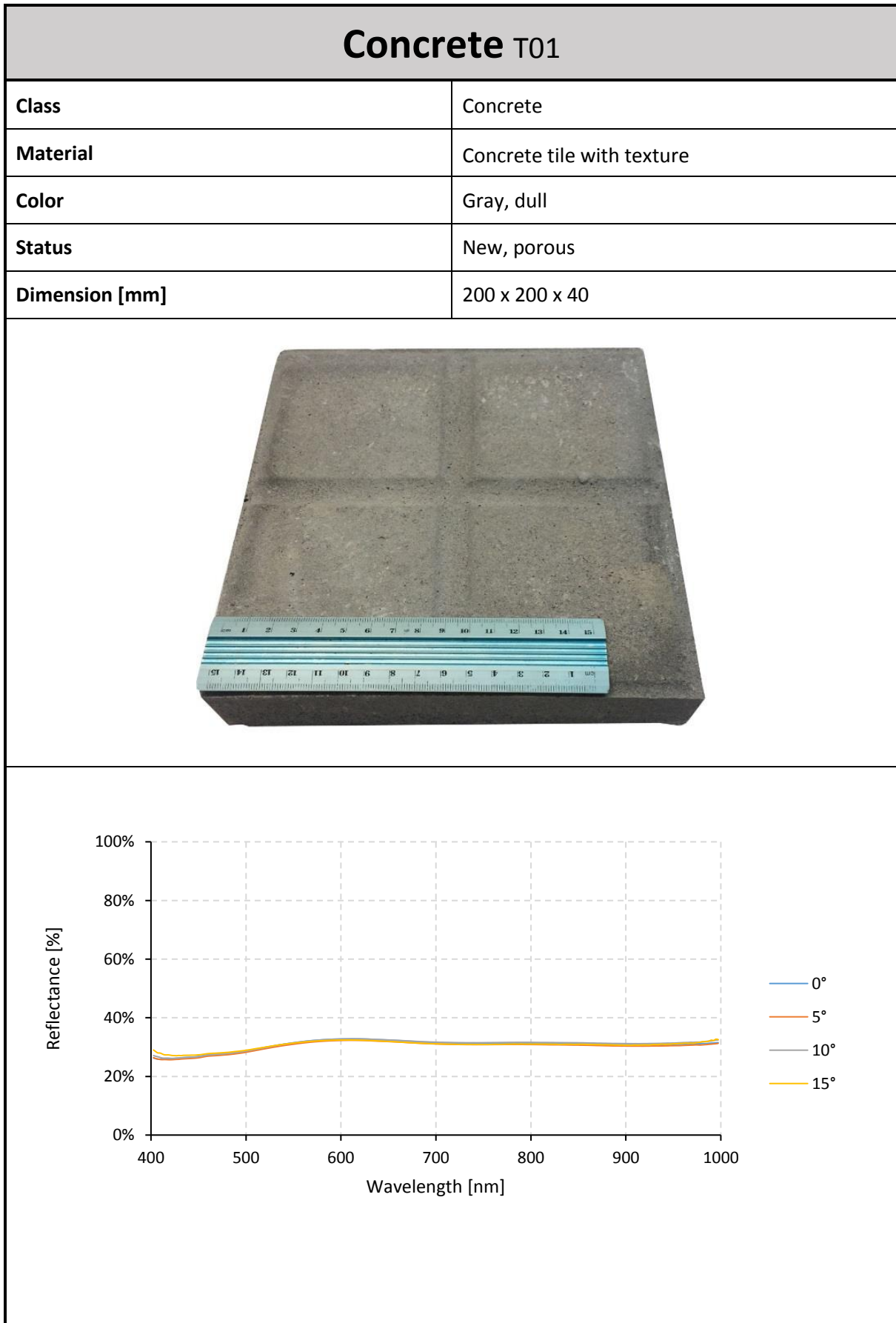
Ceramic C05

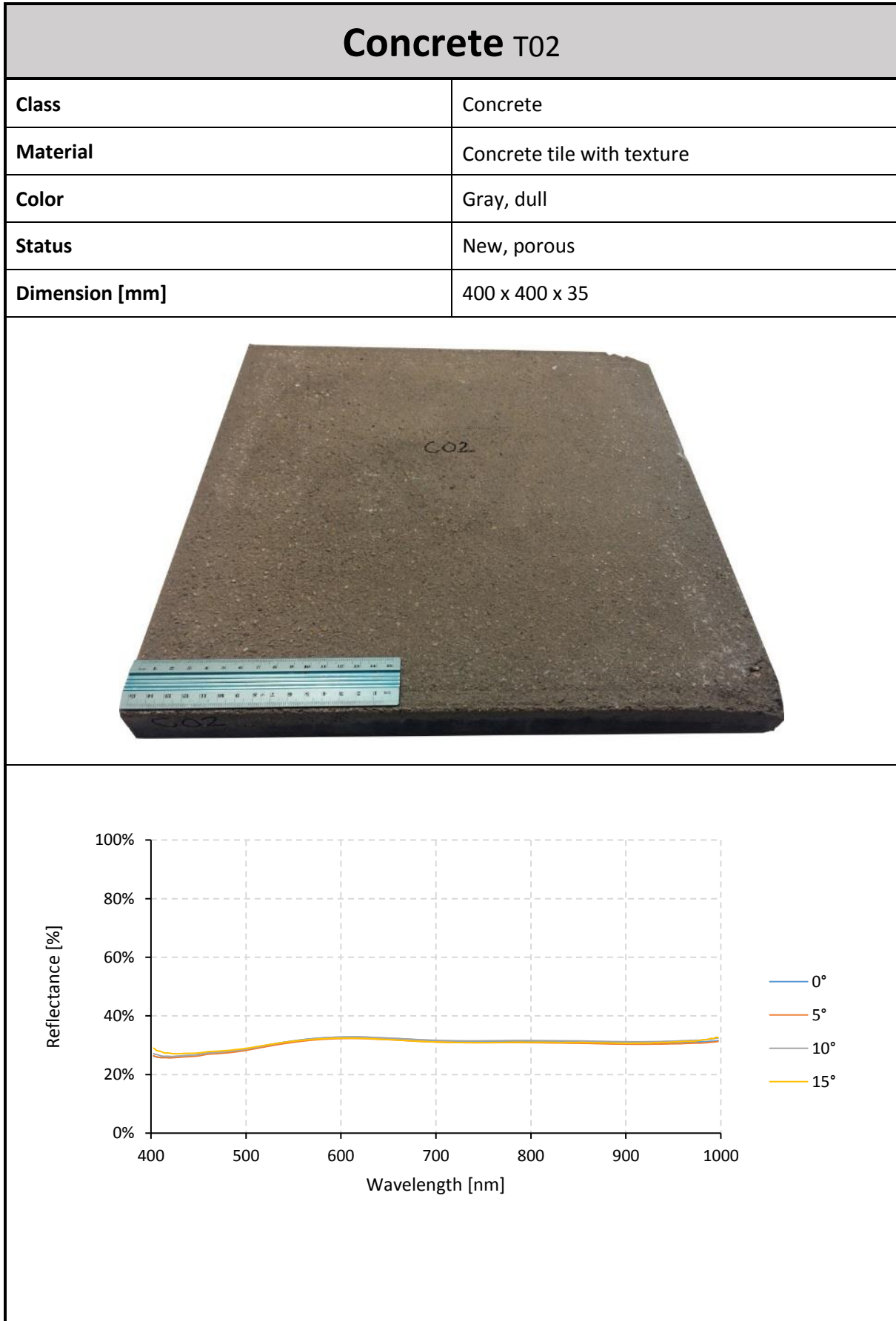
Class	Ceramic
Material	Gres porcelain tile
Color	Burnt red/brown/dark green, dull
Status	New
Dimension [mm]	315 x 315 x 5





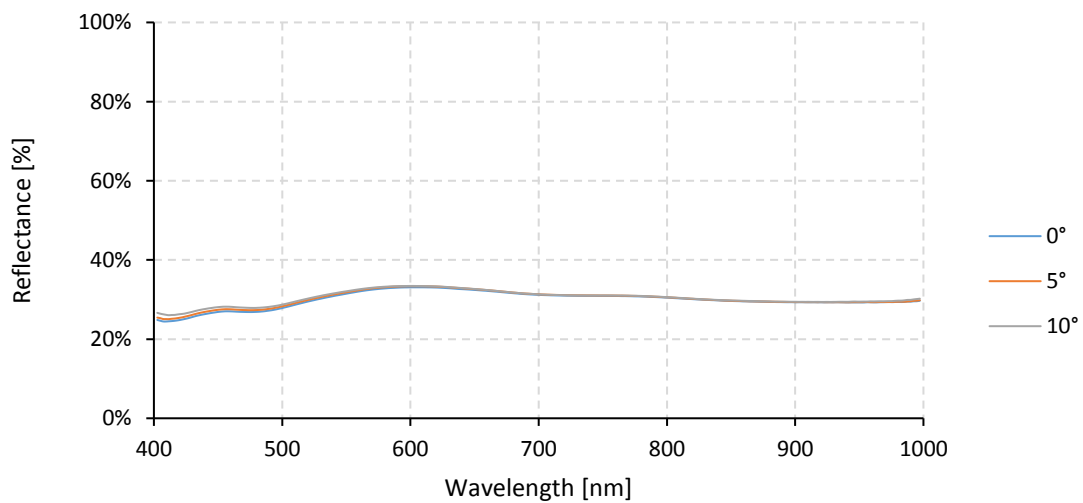
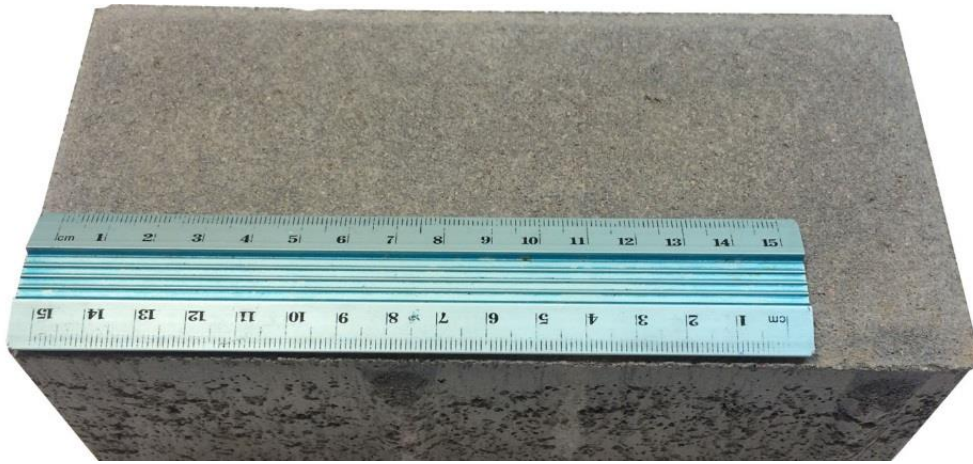
Concrete/cement





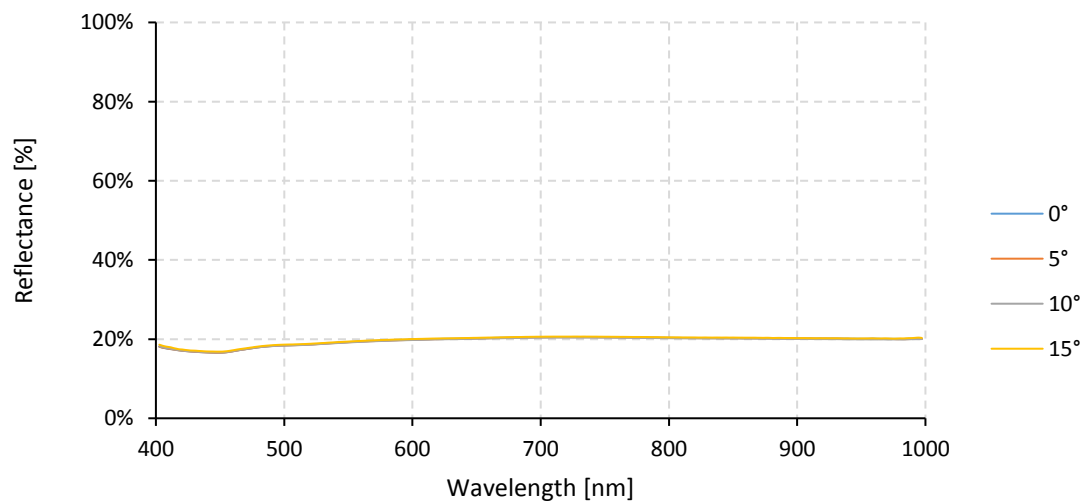
Concrete T03

Class	Concrete
Material	Concrete brick
Color	gray, dull
Status	New, porous
Dimension [mm]	95 x 200 x 75



Cement T04

Class	Cement
Material	Corrugated fiber cement shingle
Color	Gray, dull
Status	New
Dimension [mm]	300 x 300 x 3

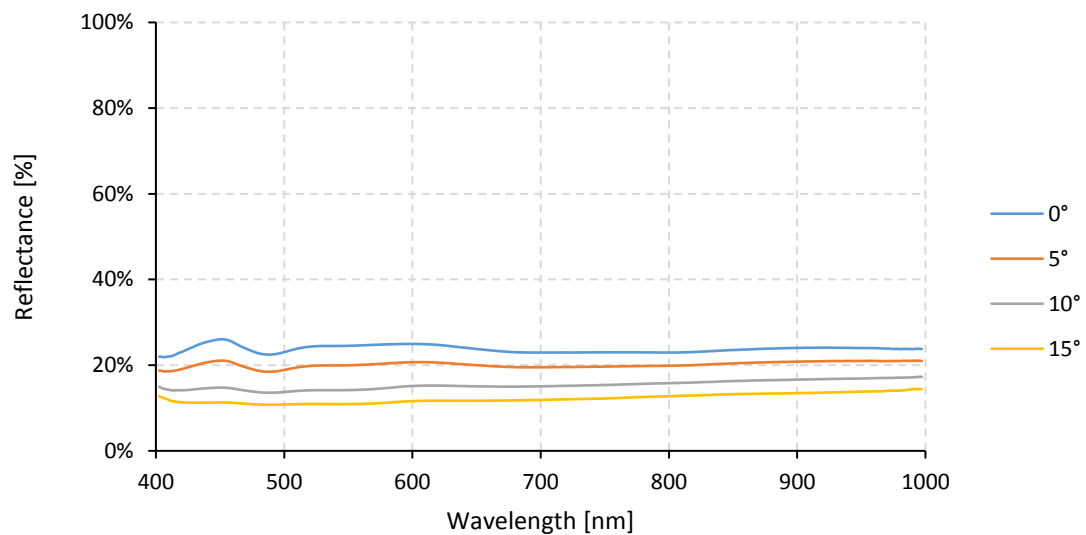
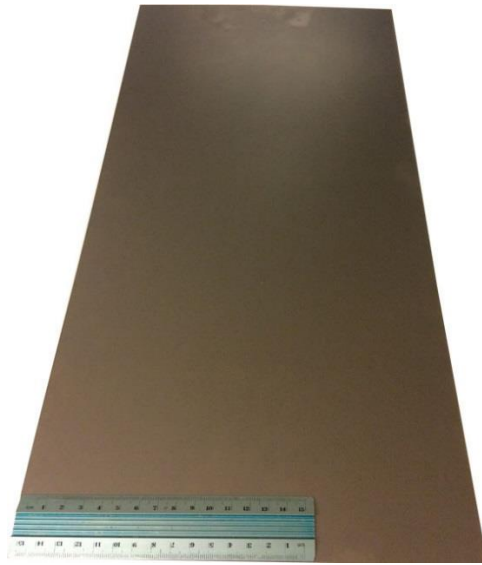


3

metal

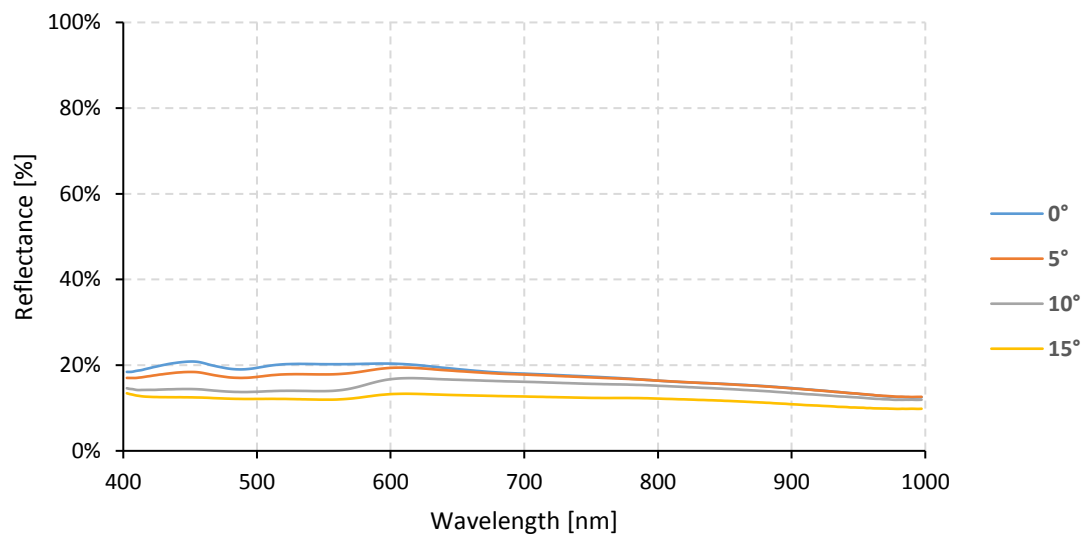
Metal M01

Class	Metal
Material	Steel shingle
Color	Gray
Status	New, smooth
Dimension [mm]	250 x 500 x.06



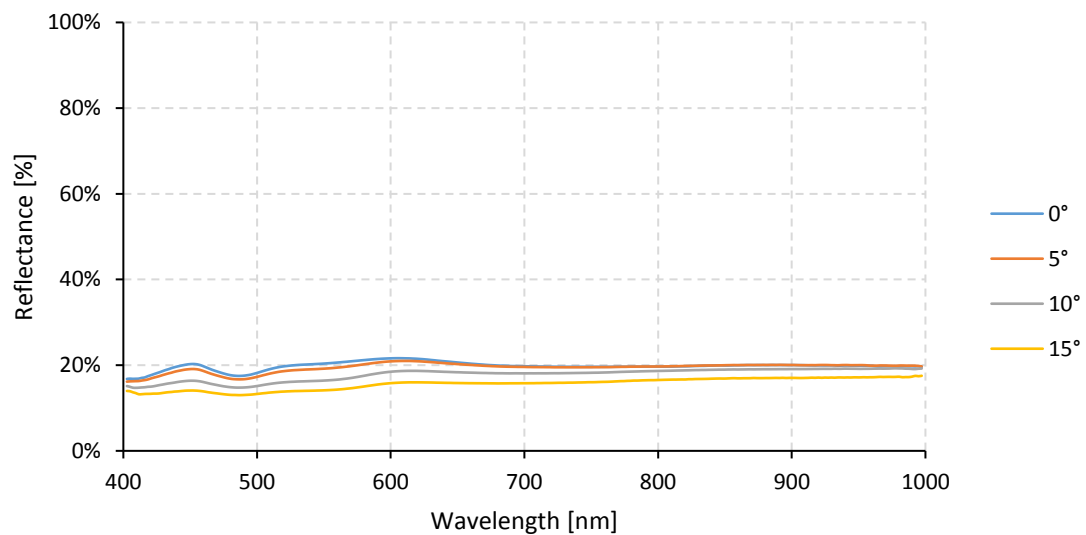
Metal M02

Class	Metal
Material	Galvanized steel shingle
Color	Gray, shiny
Status	New, smooth
Dimension [mm]	250 x 500 x .06



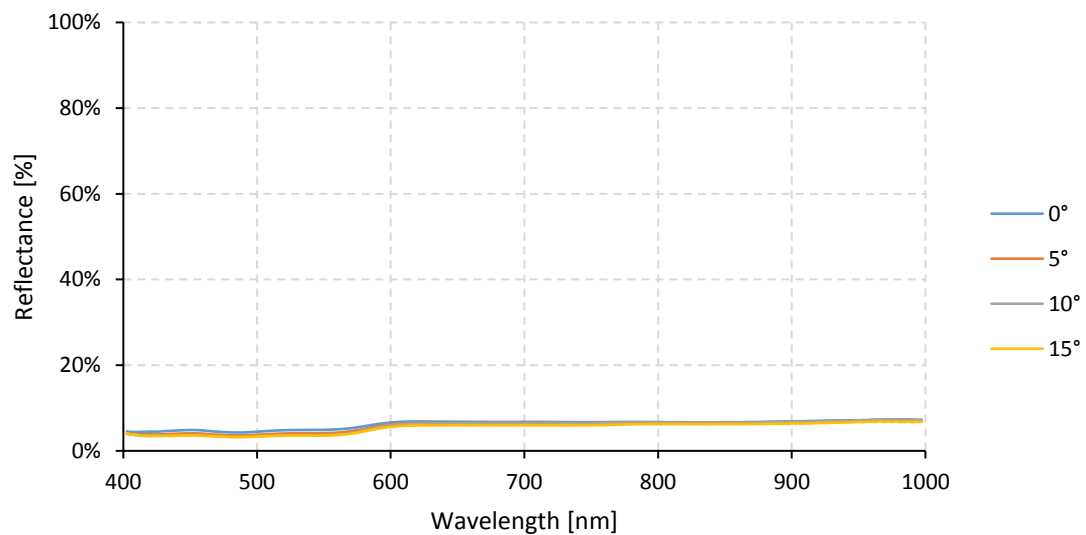
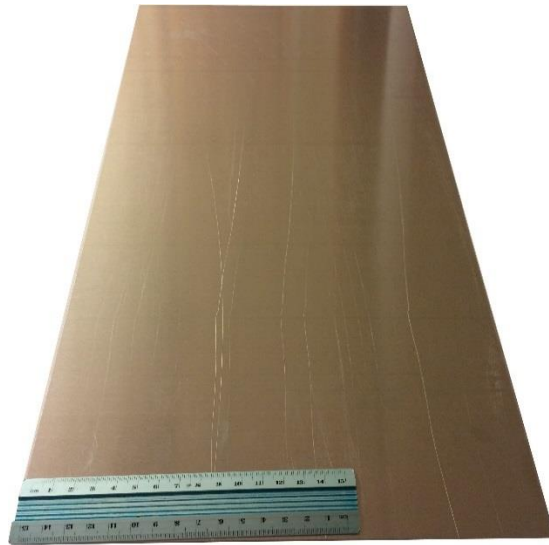
Metal M03

Class	Metal
Material	Inox steel shingle
Color	Gray, shiny
Status	New, smooth
Dimension [mm]	250 x 500 x .05



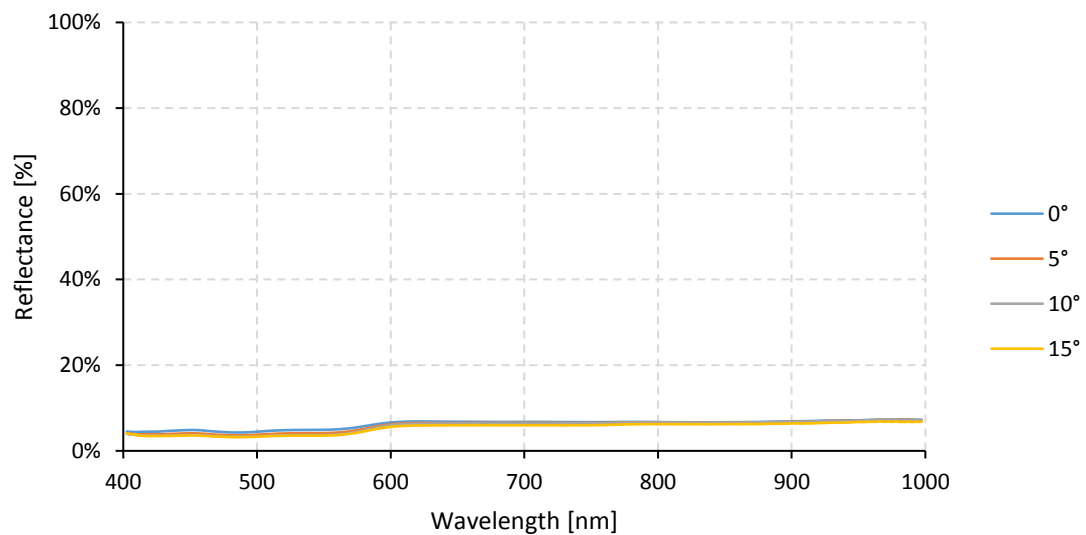
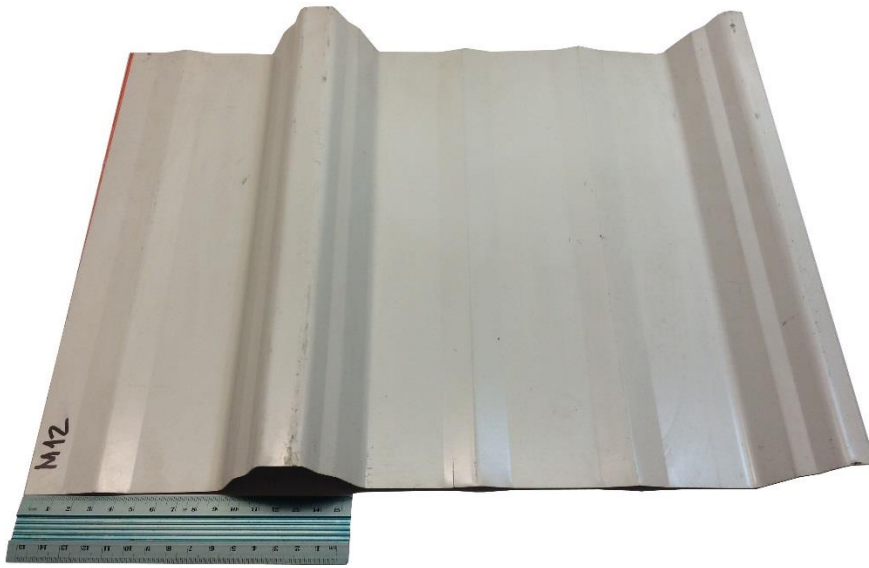
Metal M04

Class	Metal
Material	Aluminum shingle
Color	Gray
Status	New, smooth, polished
Dimension [mm]	250 x 500 x 1



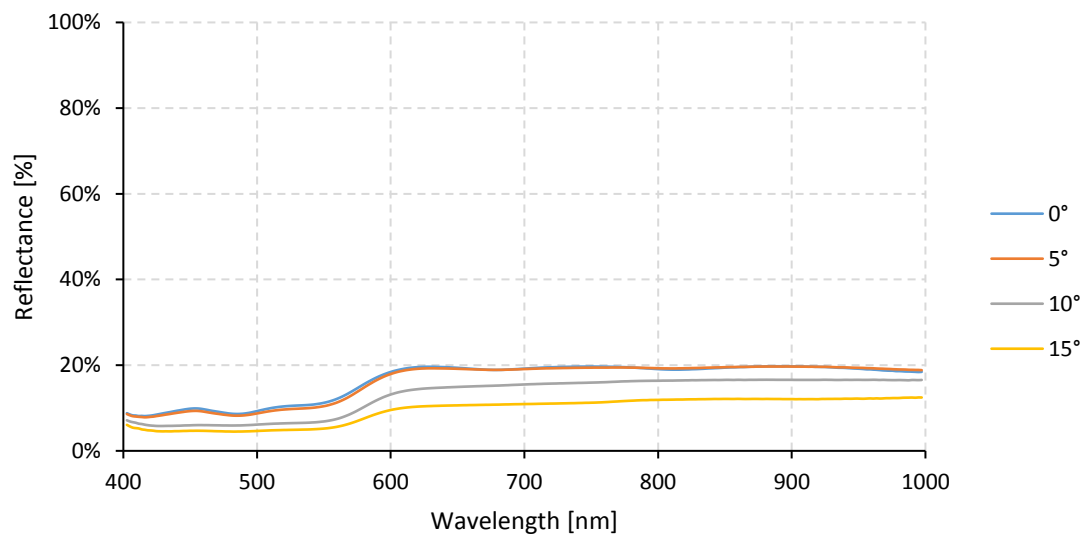
Metal M05

Class	Metal
Material	Steel shingle with paint (Europerfil®)
Color	Beige
Status	New, smooth
Dimension [mm]	400 x 300 x .05



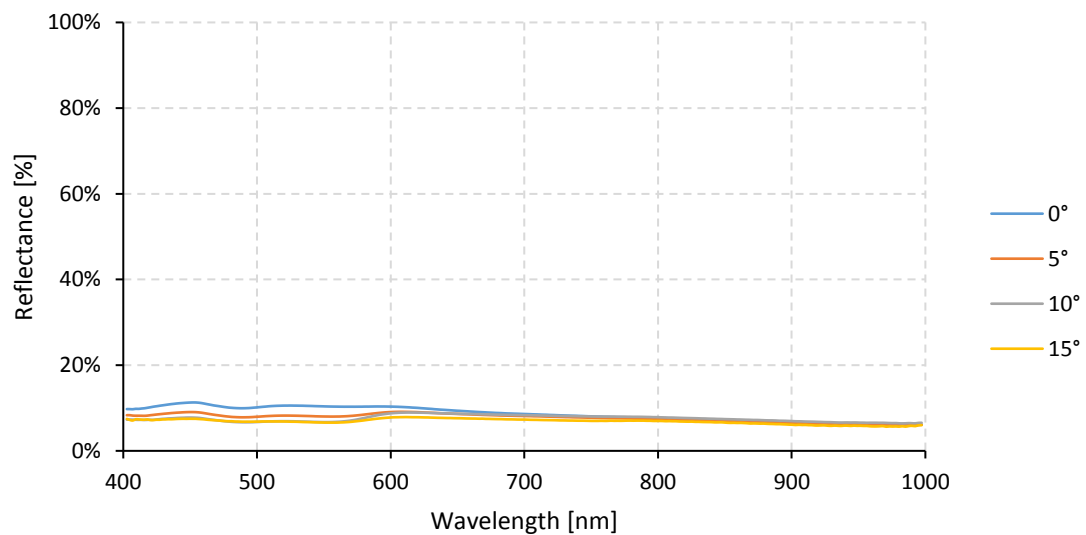
Metal M06

Class	Metal
Material	Copper shingle
Color	Copper
Status	New, smooth
Dimension [mm]	250 x 500 x .05



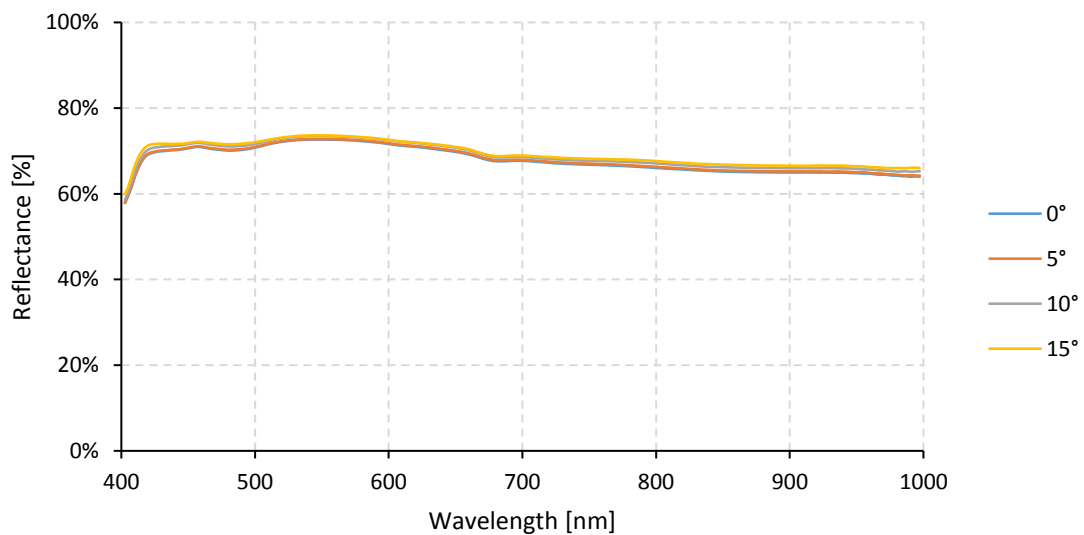
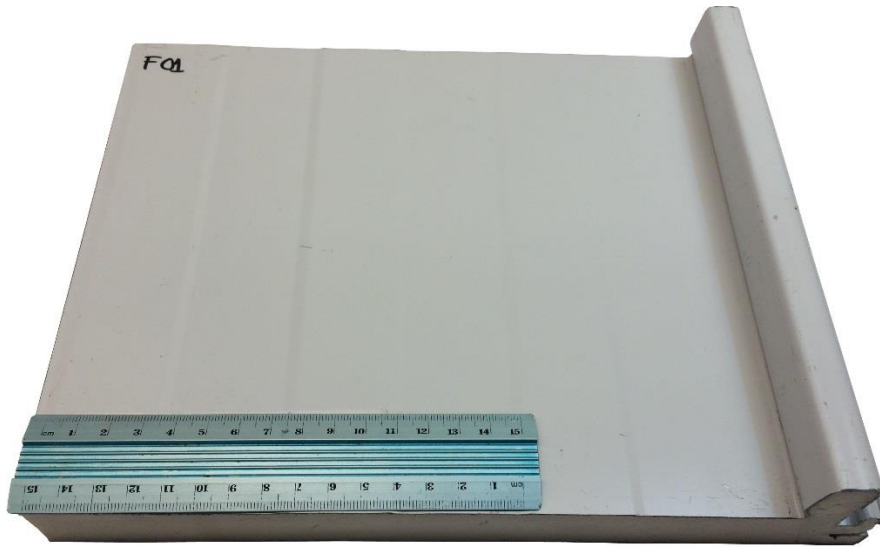
Metal M07

Class	Metal
Material	Zinc shingle
Color	Gray
Status	New, smooth
Dimension [mm]	250 x 500 x .06



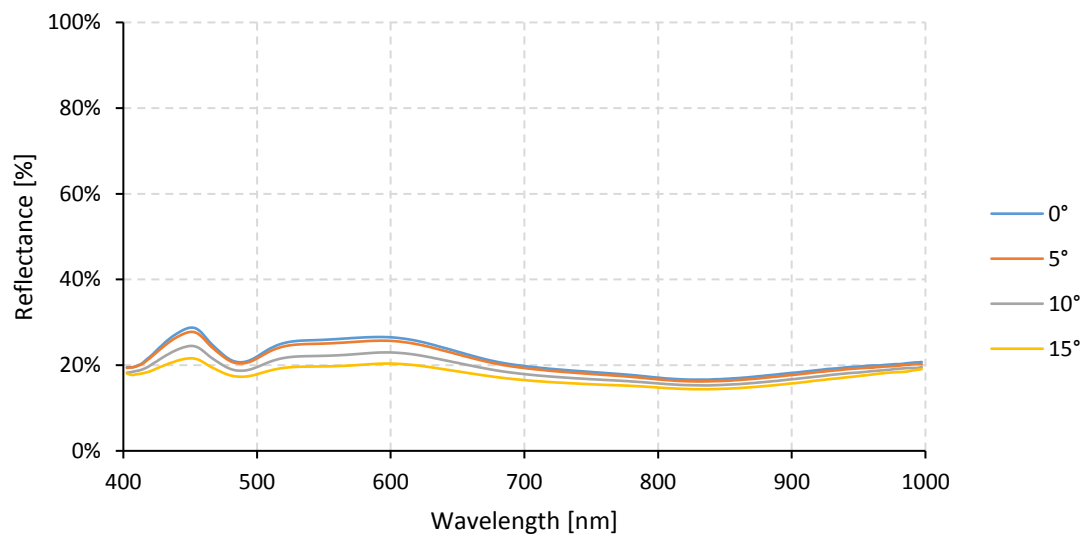
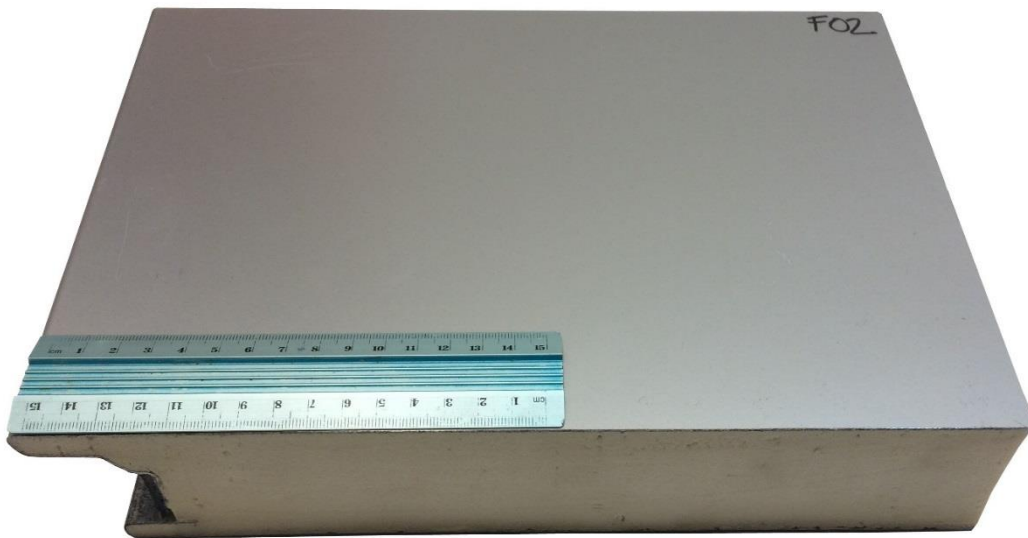
Metal M08

Class	Metal
Material	Steel with paint sandwich panel (Europerfil®)
Color	Beige
Status	New, smooth
Dimension [mm]	400 x 300 x 35



Metal M09

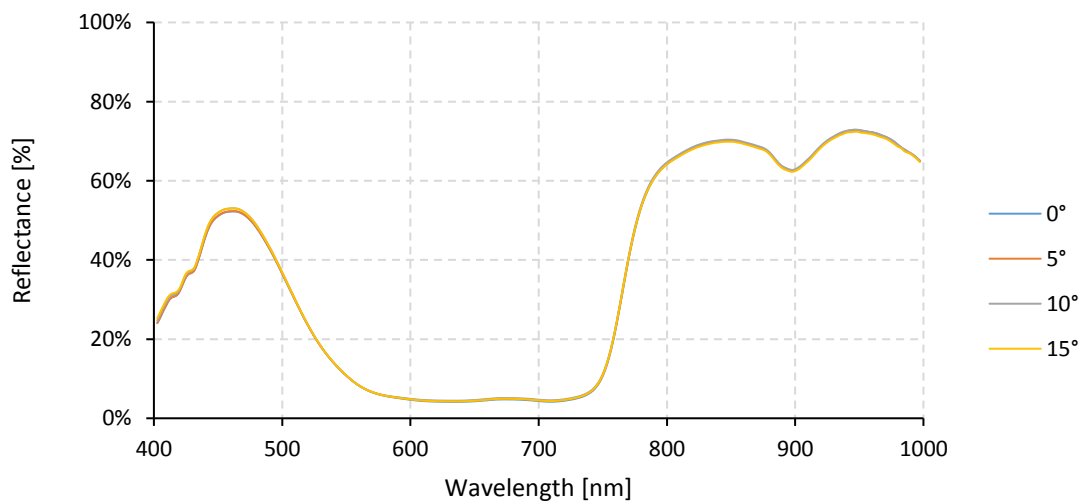
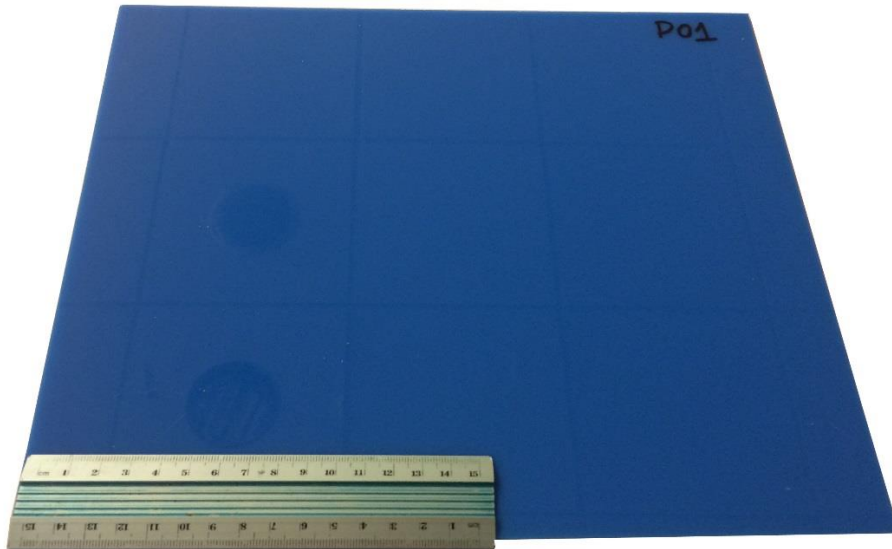
Class	Metal
Material	Aluminum with paint sandwich panel
Color	Gray, dull
Status	New, smooth
Dimension [mm]	270 x 185 x 50



4 Plastic

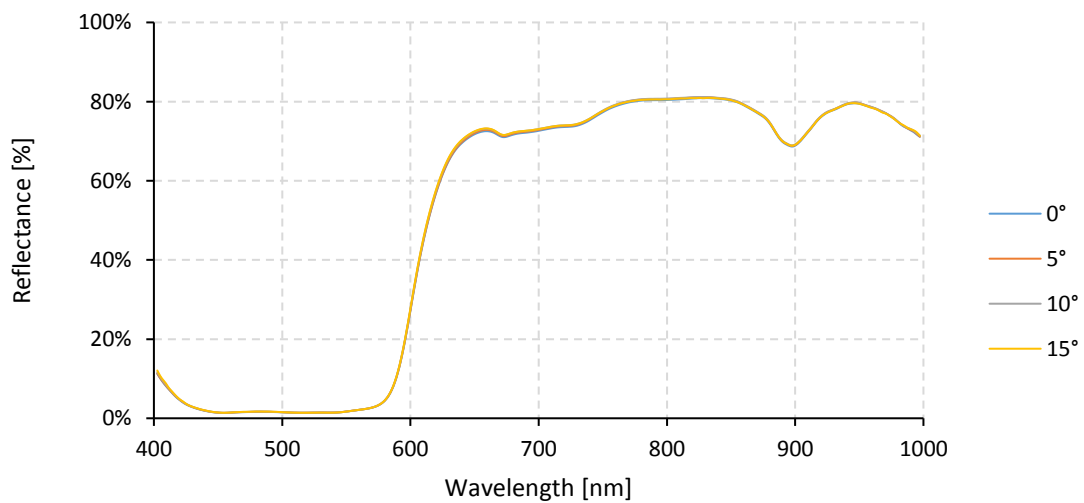
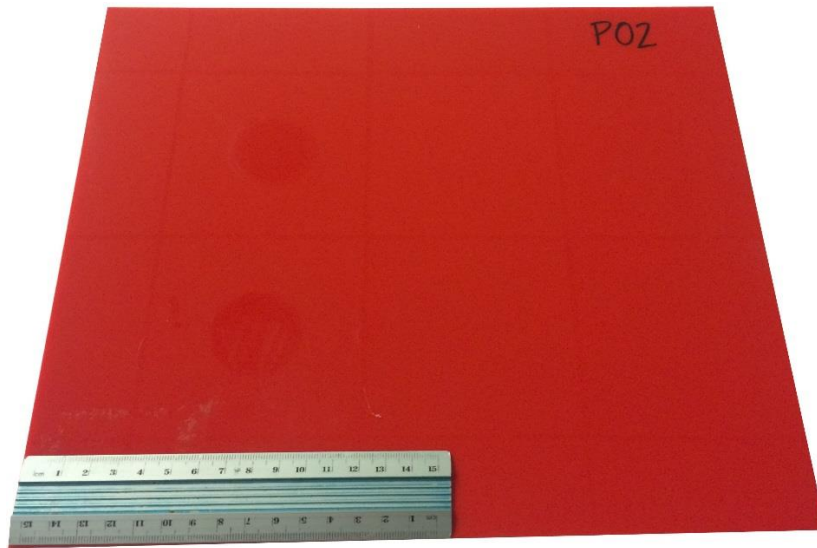
Plastic P01

Class	Plastic
Material	Methacrylate shingle
Color	Blue, shiny
Status	New, smooth
Dimension [mm]	300 x 250 x 3



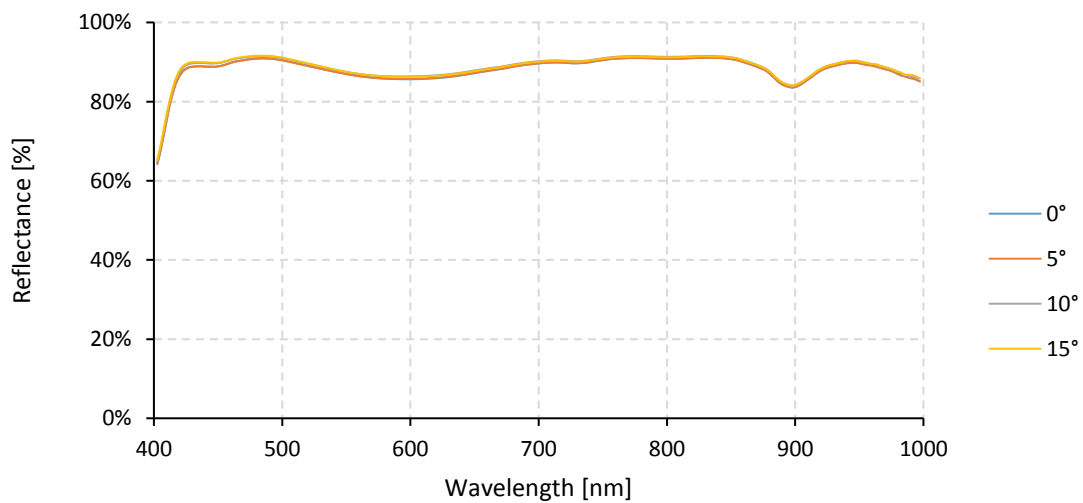
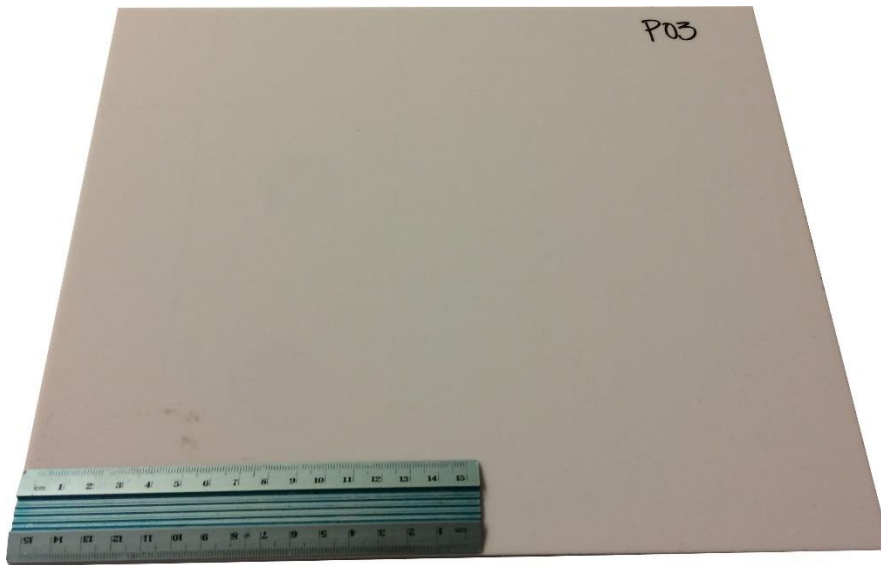
Plastic P02

Class	Plastic
Material	Methacrylate shingle
Color	Red, shiny
Status	New, smooth
Dimension [mm]	300 x 250 x 3



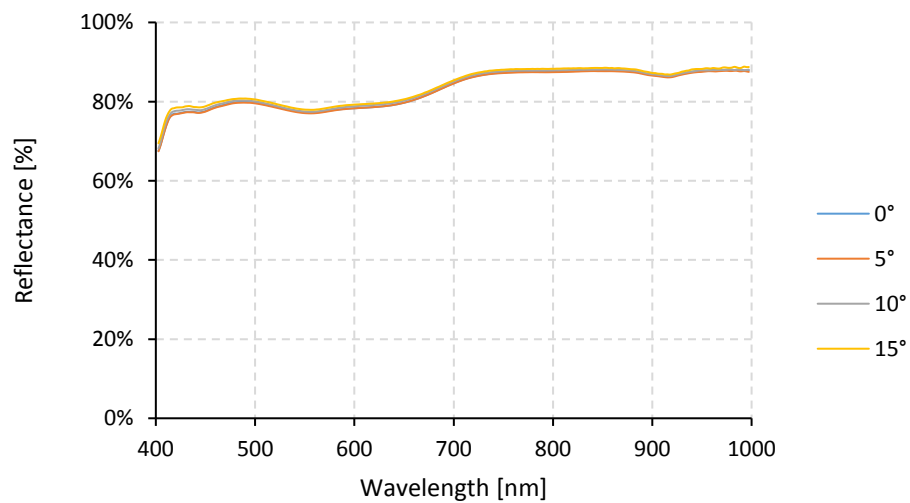
Plastic P03

Class	Plastic
Material	Methacrylate shingle
Color	White, shiny
Status	New, smooth
Dimension [mm]	300 x 250 x 3



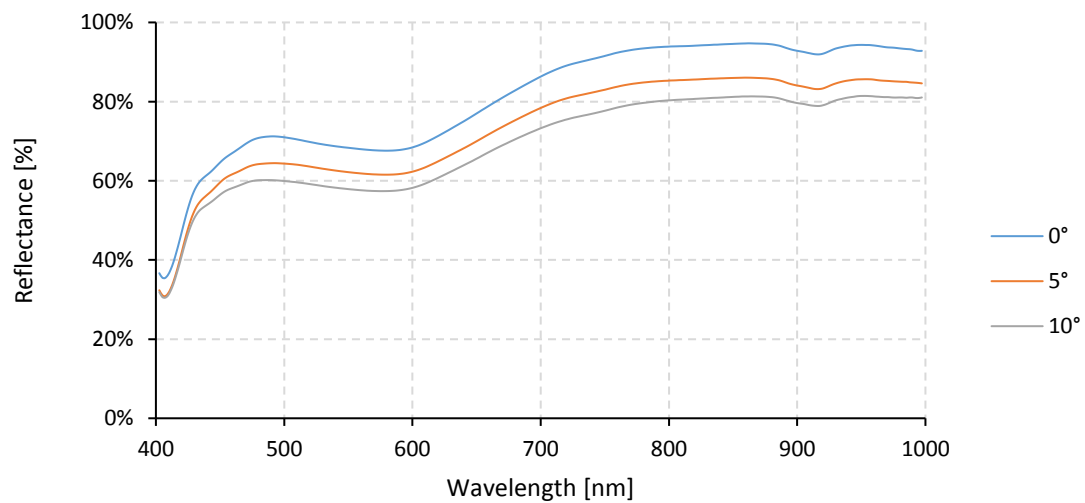
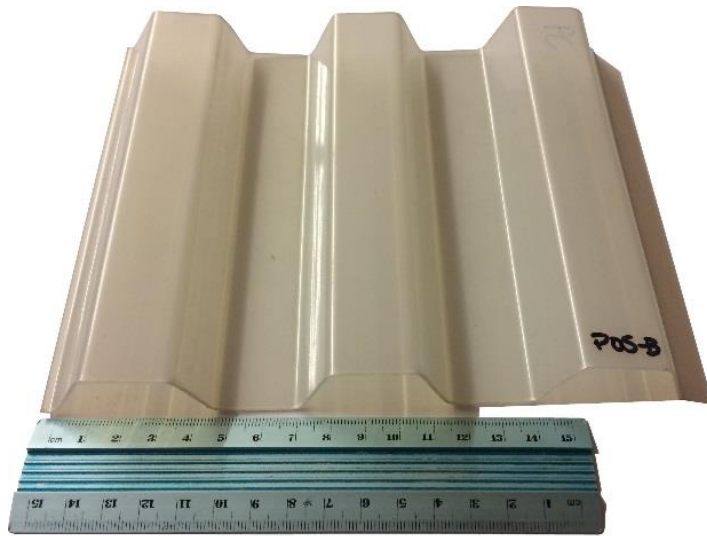
Plastic P04

Class	Plastic
Material	PVC shingle
Color	White, shiny
Status	New, smooth
Dimension [mm]	500 x 250 x 3



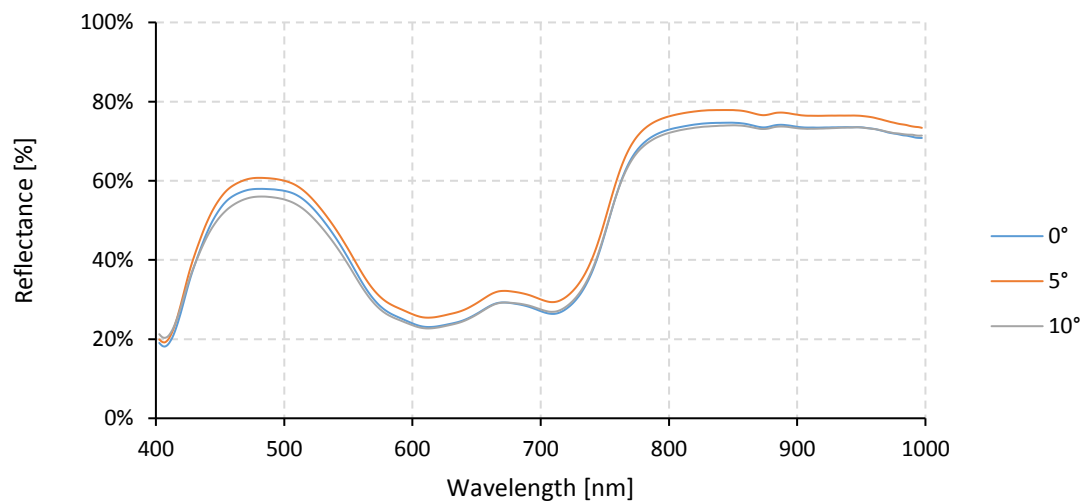
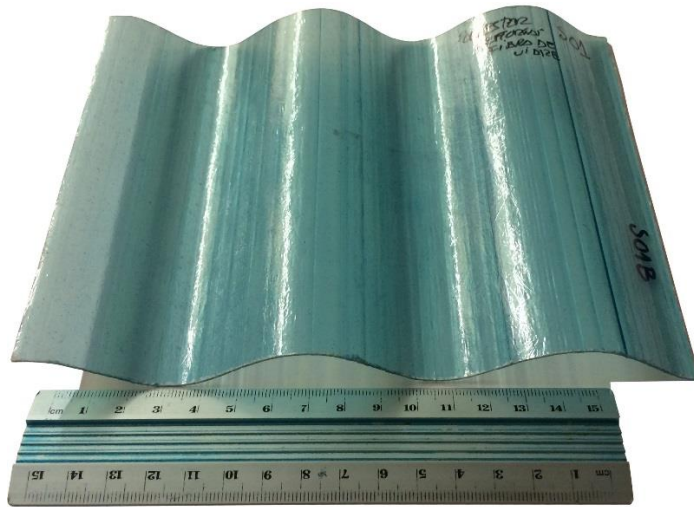
Plastic P05

Class	Plastic
Material	Polycarbonate shingle
Color	White, shiny
Status	New, smooth
Dimension [mm]	190 x 150 x 1



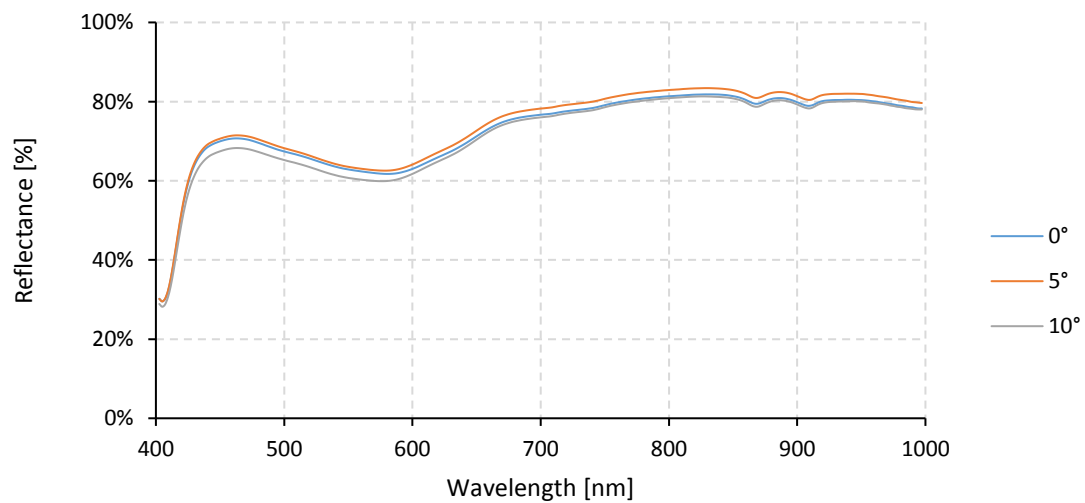
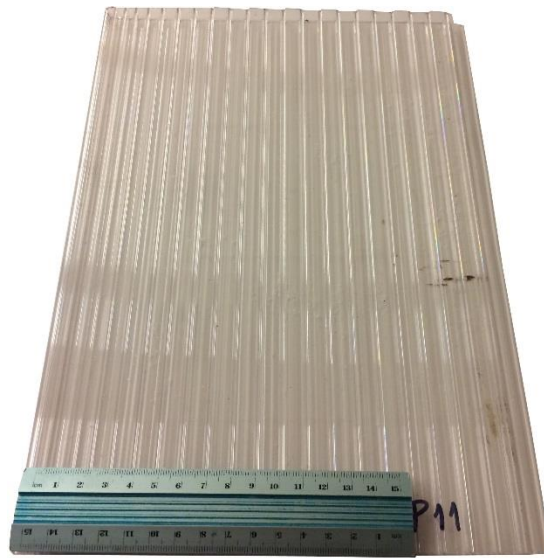
Plastic P06

Class	Plastic
Material	Polycarbonate shingle
Color	Transparent bleu, shiny
Status	New, smooth
Dimension [mm]	190 x 140 x 1



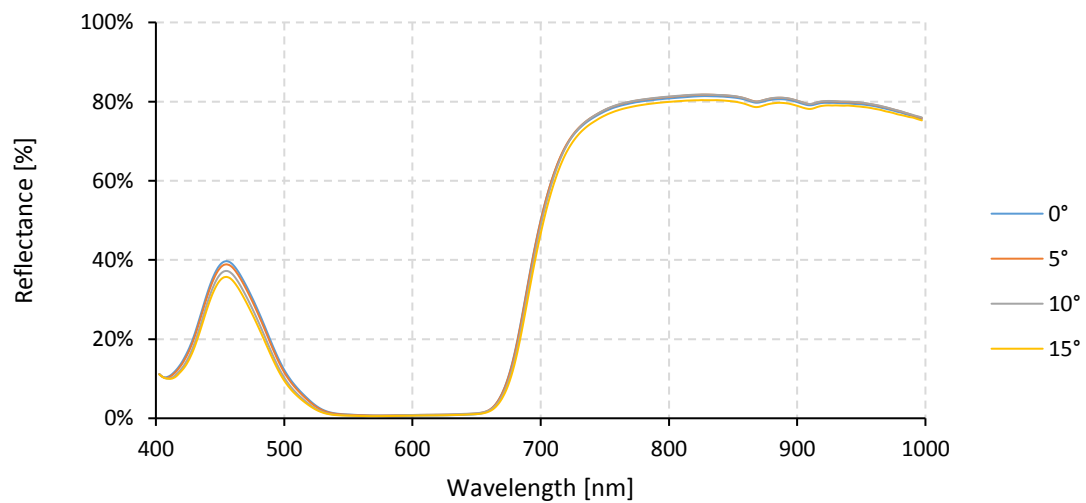
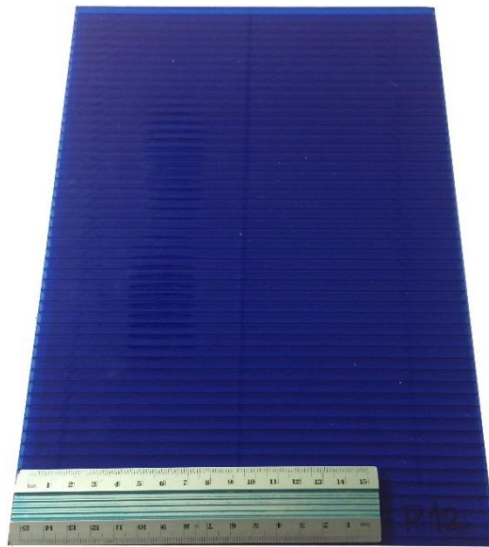
Plastic P07

Class	Plastic
Material	Polycarbonate shingle
Color	Transparent, shiny
Status	New, smooth
Dimension [mm]	210 x 297 x 8



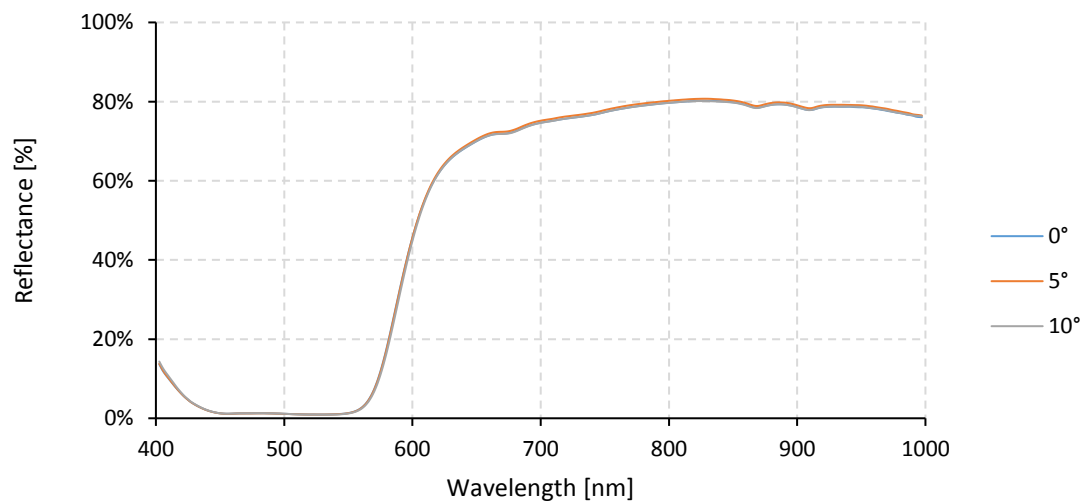
Plastic P08

Class	Plastic
Material	Polycarbonate shingle
Color	Transparent blue, shiny
Status	New, smooth
Dimension [mm]	210 x 297 x 8



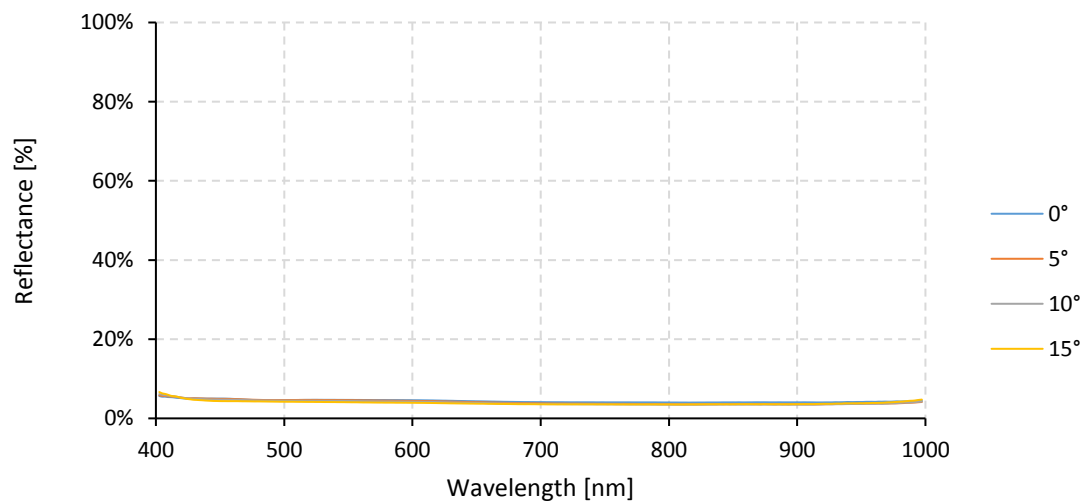
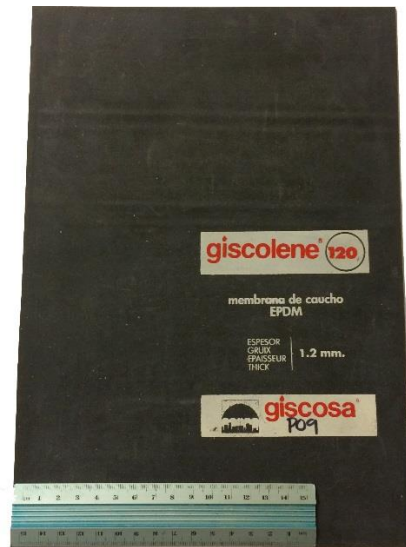
Plastic P09

Class	Plastic
Material	Polycarbonate shingle
Color	Transparent red, shiny
Status	New, smooth
Dimension [mm]	210 x 297 x 8



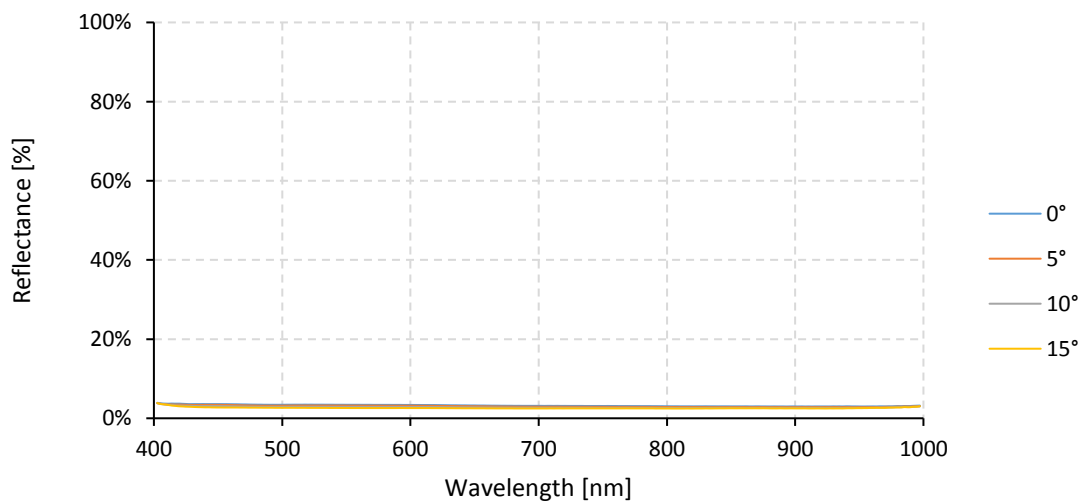
Plastic P10

Class	Plastic
Material	Synthetic rubber Ethylene propylene diene monomer (Giscolene®)
Color	Black, dull
Status	New
Dimension [mm]	210 x 310 x 1



Plastic P11

Class	Plastic
Material	Asphalt polymer
Color	Black, dull
Status	New
Dimension [mm]	300 x 300 x 1

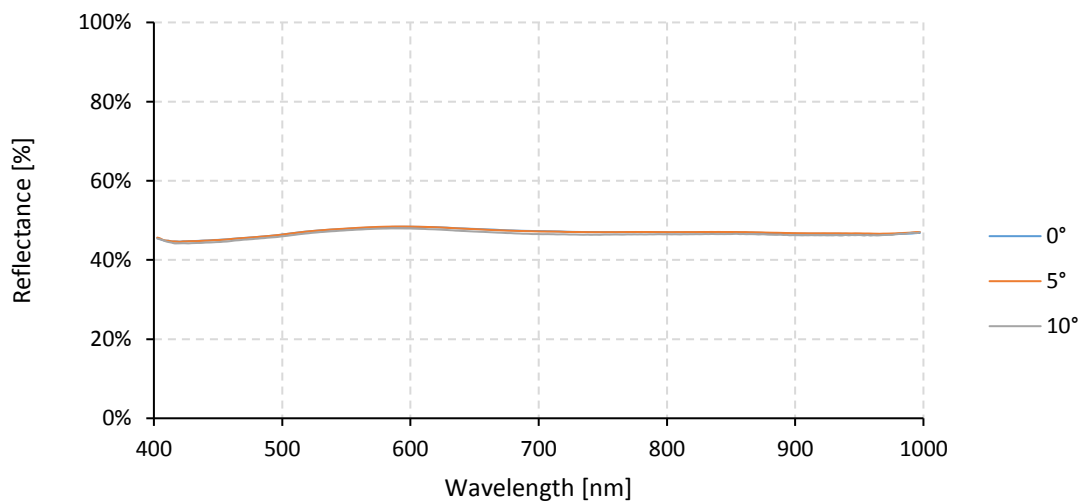


5

Stone

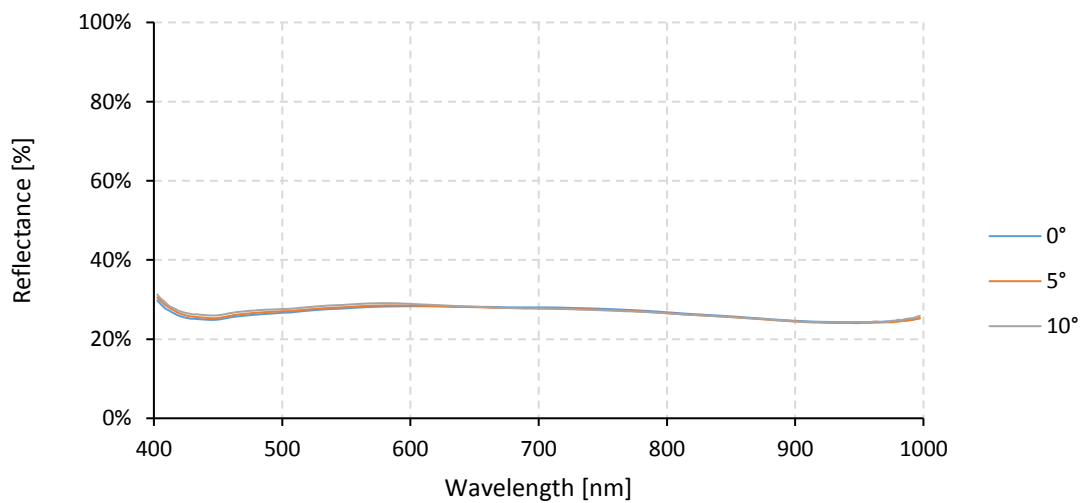
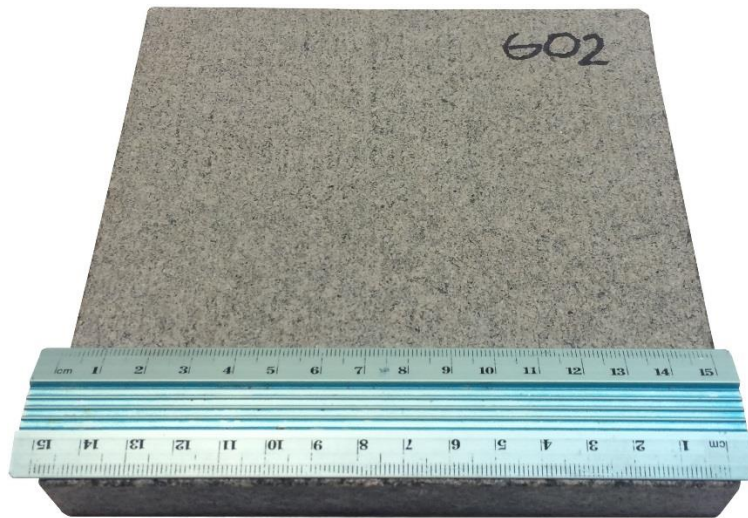
Stone S01

Class	Stone
Material	Granite tile
Color	White/black, dull
Status	New
Dimension [mm]	150 x 150 x 20



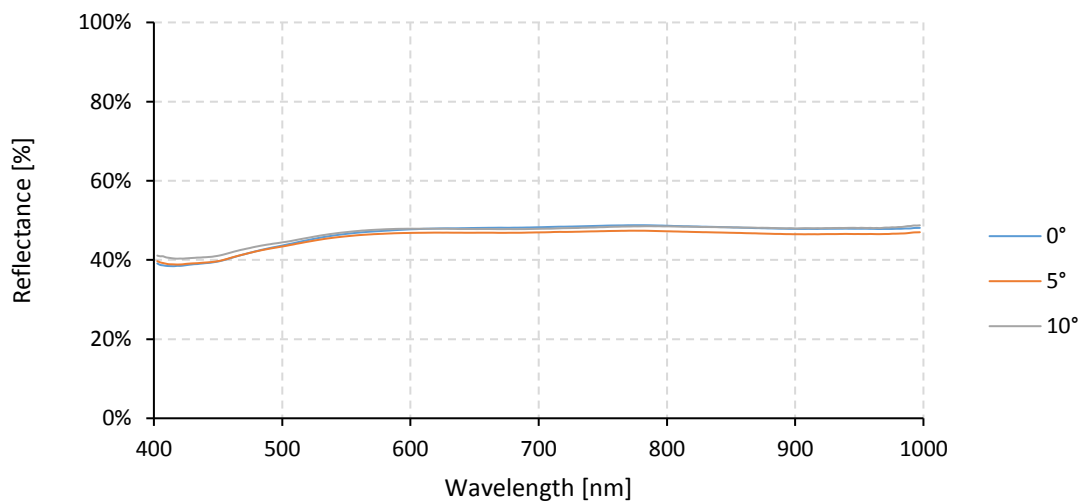
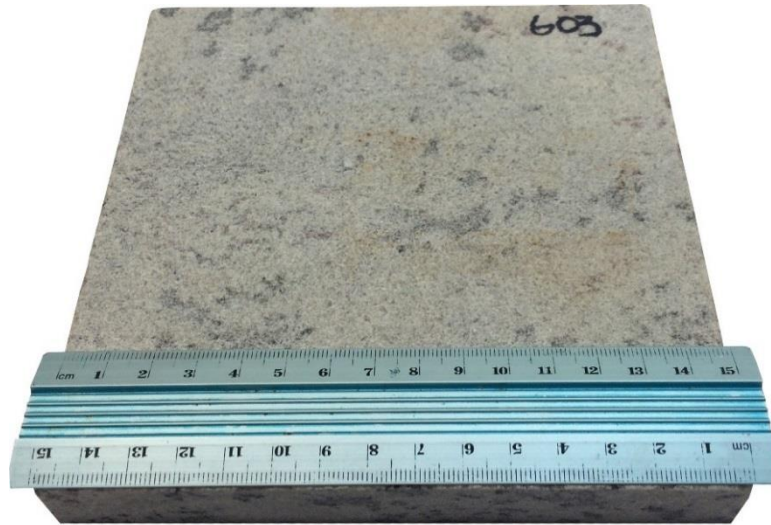
Stone S02

Class	Stone
Material	Granite tile
Color	Black/gray/white, dull
Status	New
Dimension [mm]	150 x 150 x 20



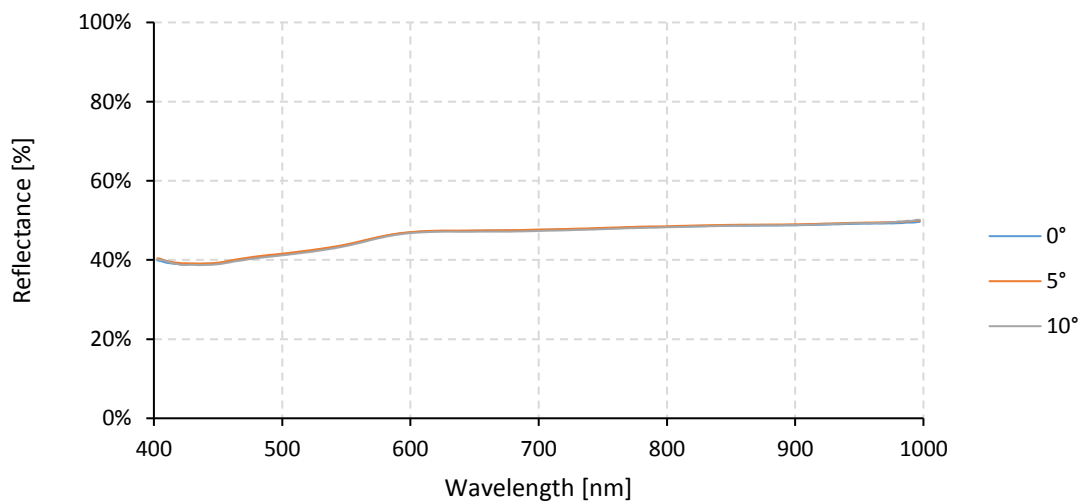
Stone S03

Class	Stone
Material	Granite tile
Color	White/green, dull
Status	New
Dimension [mm]	150 x 150 x 20



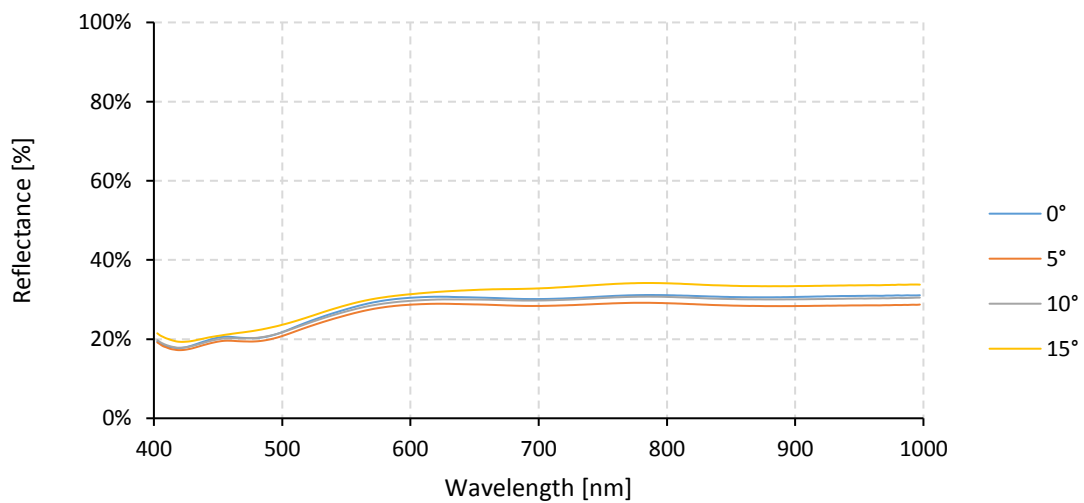
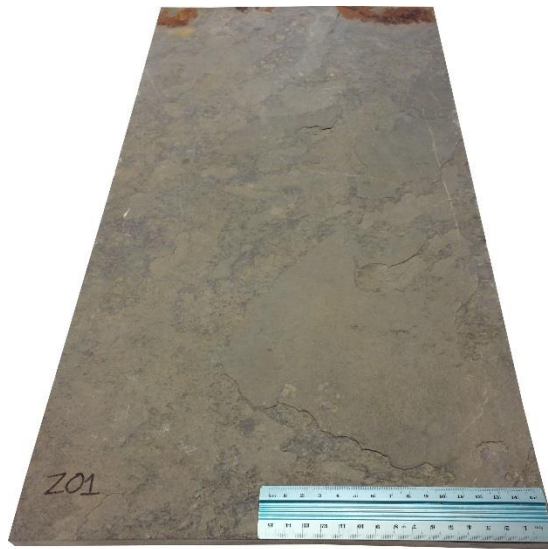
Stone S04

Class	Stone
Material	Granite tile
Color	White/pink/ black, dull
Status	New
Dimension [mm]	150 x 150 x 20



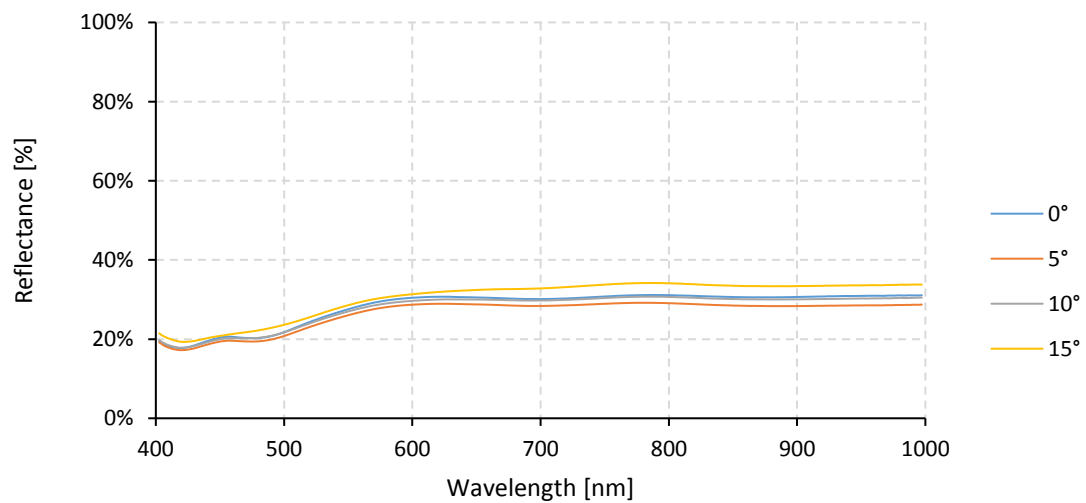
Stone S05

Class	Stone
Material	Slate tile whit texture
Color	Gray, dull
Status	New
Dimension [mm]	300 x 600 x 10



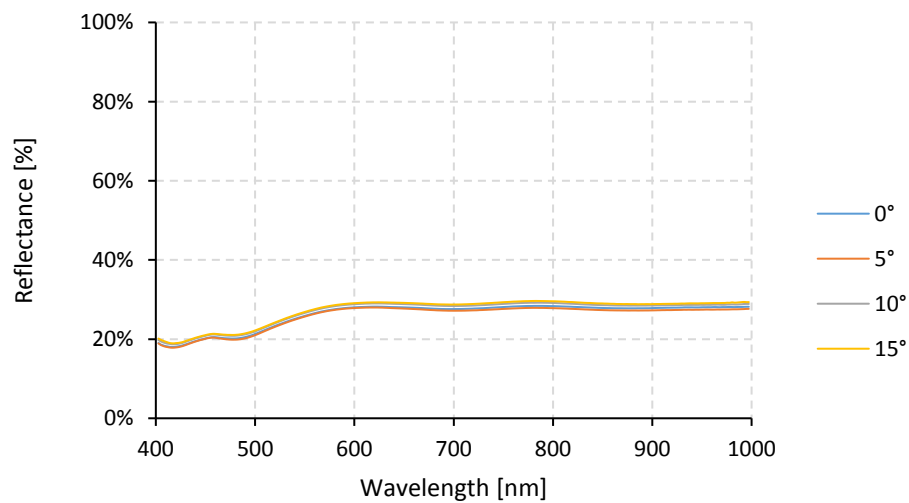
Stone S06

Class	Stone
Material	Gravel
Color	Gray, beige dull
Status	New
Dimension [mm]	4-12



Stone S07

Class	Stone
Material	Gravel
Color	Gray, beige dull
Status	New
Dimension [mm]	2-6

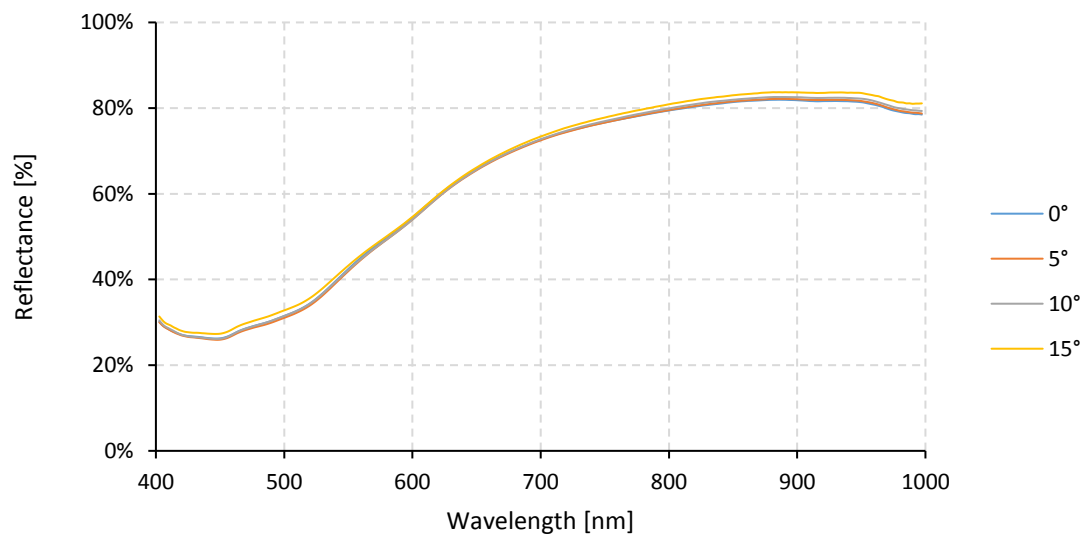
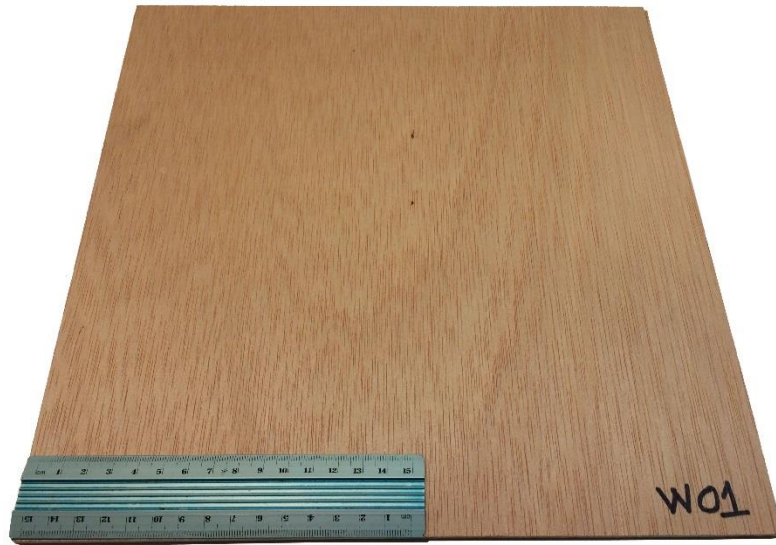




Wood

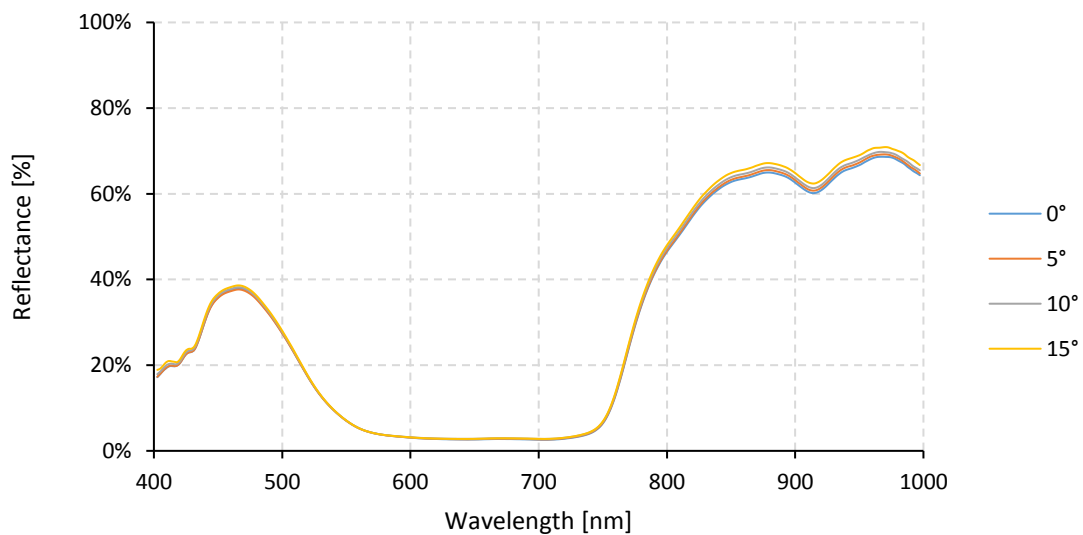
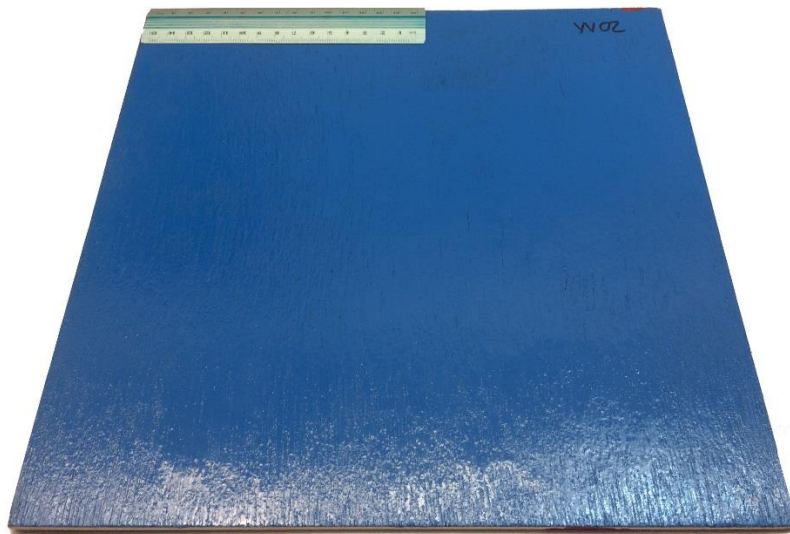
Wood W01

Class	Wood
Material	Wood shingle
Color	Light brown, dull
Status	New
Dimension [mm]	300 x 300 x 10



Wood W02

Class	Wood
Material	Wood shingle with blue paint
Color	Blue, synthetic enamel (Tintalux 539)
Status	New
Dimension [mm]	300 x 300 x 10



Wood W03

Class	Wood
Material	Wood shingle with red paint
Color	Red, synthetic enamel (Tintalux 523)
Status	New
Dimension [mm]	300 x 300 x 10

