UNIVERSITY OF ATHENS
SCHOOL OF PHYSICS
DEPARTMENT OF APPLIED PHYSICS

EVALUATION OF THE OPTICAL PROPERTIES OF THREE SAMPLES OF MATERIALS OF A COMPANY

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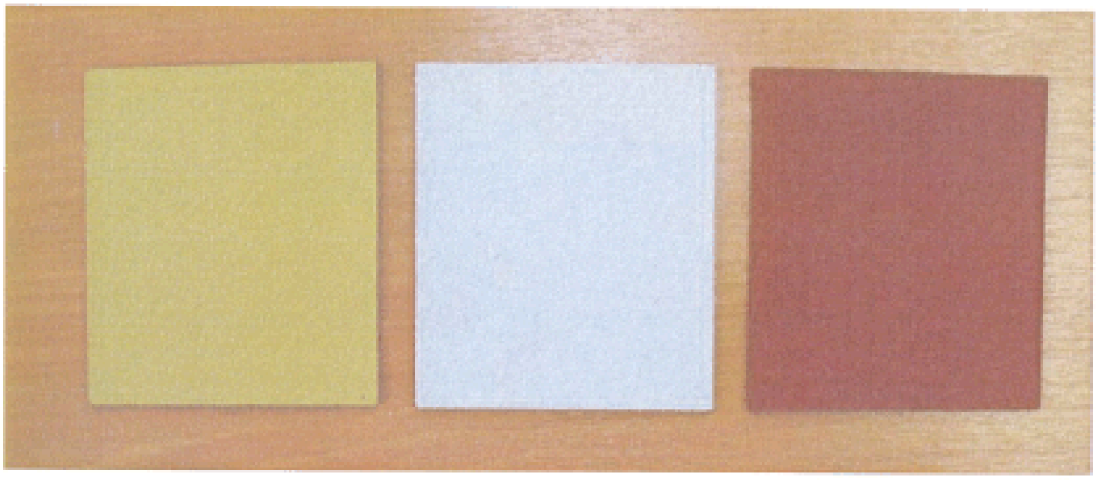
EVALUATION OF THE OPTICAL PROPERTIES OF THREE SAMPLES OF MATERIALS



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CONTENTS

1. INTRODUCTION

This study presents the results of the evaluation of the optical properties of three materials, which were delivered for testing by the company **KDF - KATASKEVES DAPEDON LTD**.

The research includes:

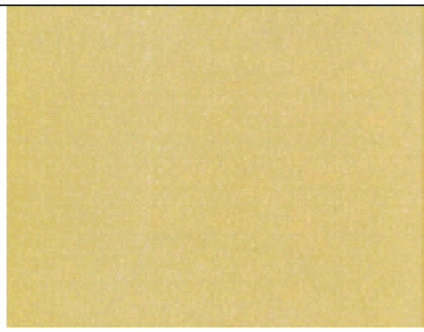
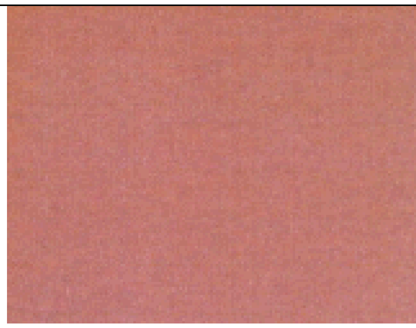
- measurements of the spectral reflectance of the samples
- the calculation of solar reflectance.
- measurements of emissivity in the infra-red spectrum

The study was conducted by the Building Environment Research Group of the University of Athens, School of Physics, Department of Applied Physics.

2. EXPERIMENTAL PROCEDURE AND RESULTS

The studied samples of the materials are presented in the following Table 1.

Tab. 1 Description of the samples

s/n	Designation	Sample
1	Yellow sample	
2	White sample	
3	Red sample	

2.1 Measurements of spectral reflectance

The spectral reflectance of the samples was measured in a 300-2500 nm wavelength region of the electromagnetic spectrum of solar radiation, which includes a part of ultraviolet radiation (UV: 300-400 nm), the visible wavelength (VIS: 400-700 nm) and the near infra-red wavelength (NIR: 700-2500 nm) parts of the spectrum.

For the measurements, we used a spectrophotometer (Varian Carry 5000) fitted with a six-inch (150 mm) diameter integrating sphere (Labsphere DRA 2500), which collects both specular and diffuse radiation. As a standard reference material, we used a PTFE plate (Labsphere). The measurements were performed in accordance with ASTM E903-96.

The following Figures 1-3 show the results of the spectral measurements.

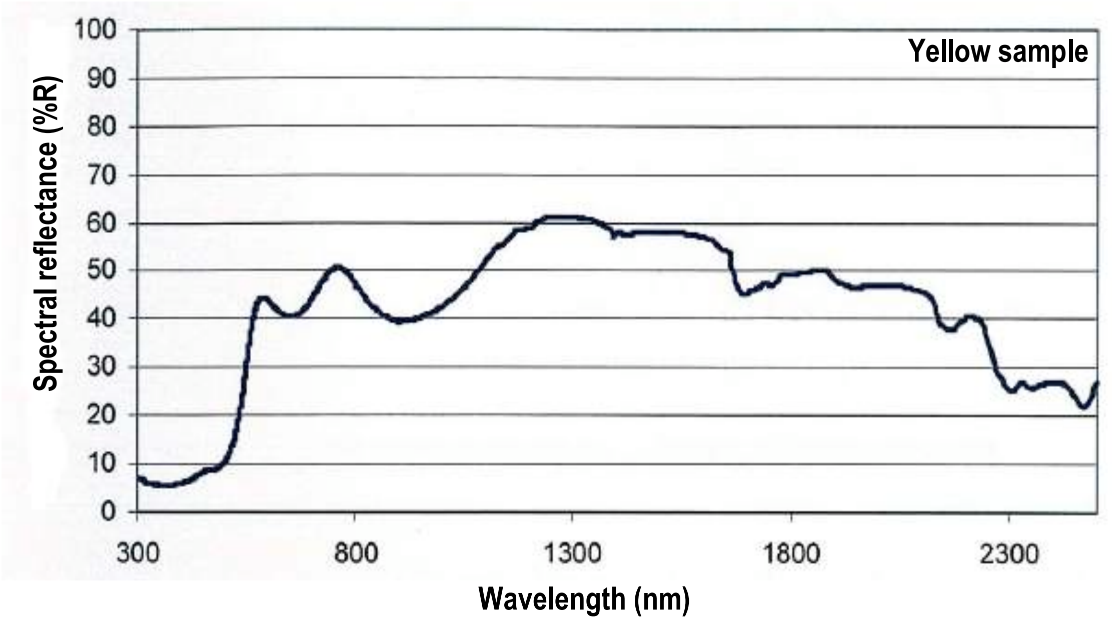


Fig. 1 The spectral reflectance of 1. Yellow sample

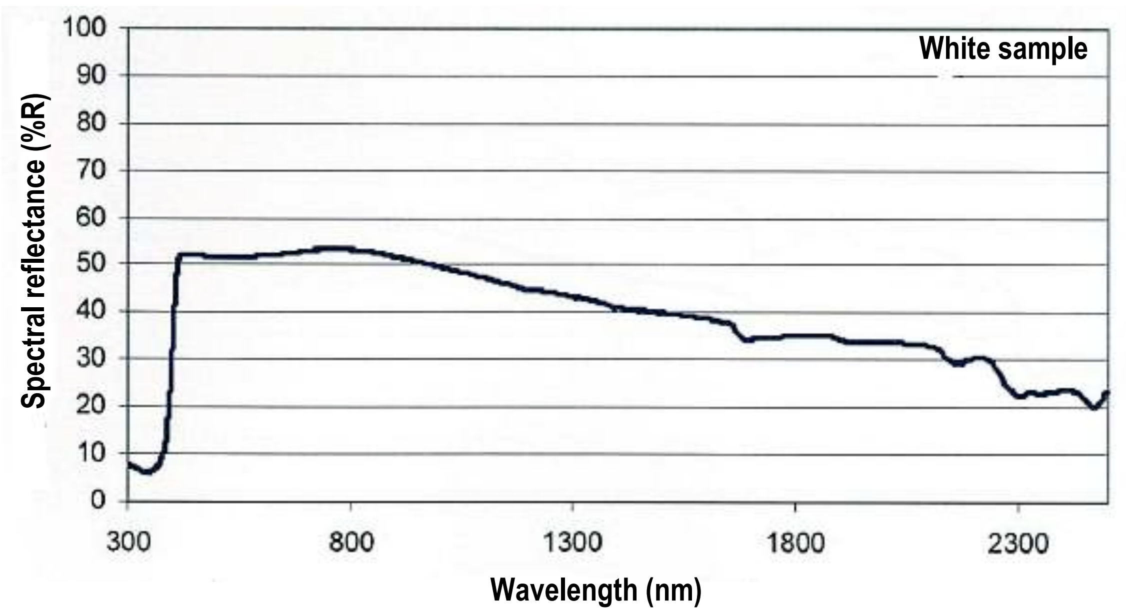


Fig. 2 The spectral reflectance of 2. White sample

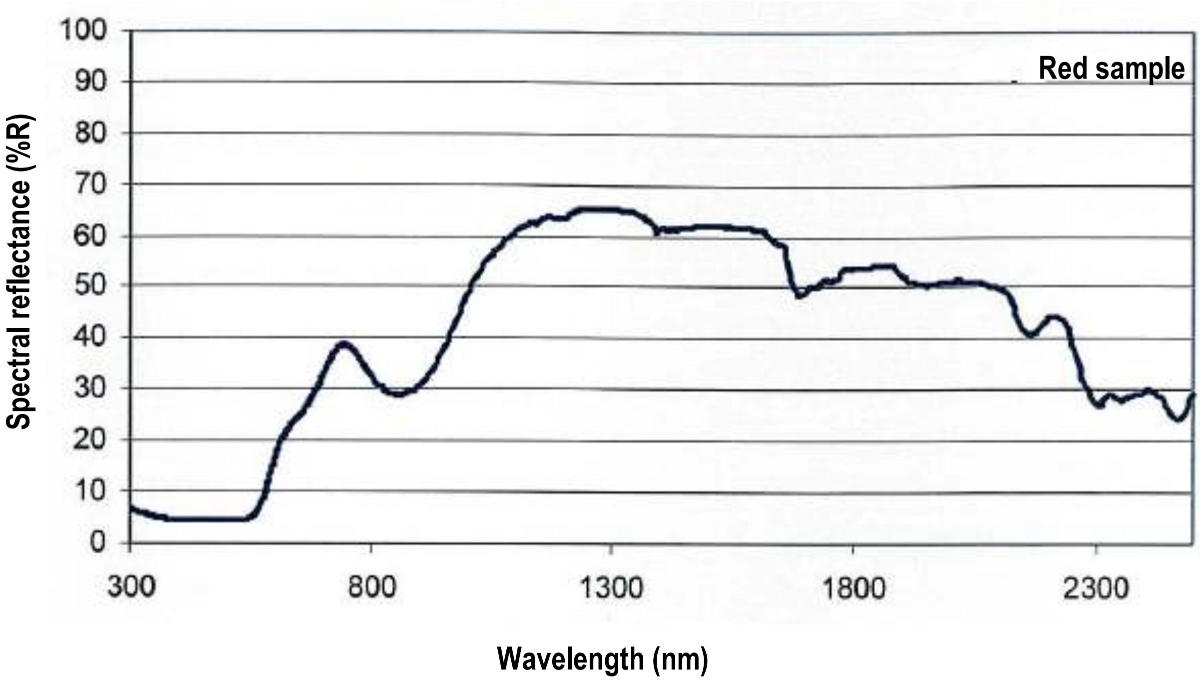


Fig. 3 The spectral reflectance of 3. Red sample

The following Figure 4 depicts the comparative spectral reflectances of all samples.

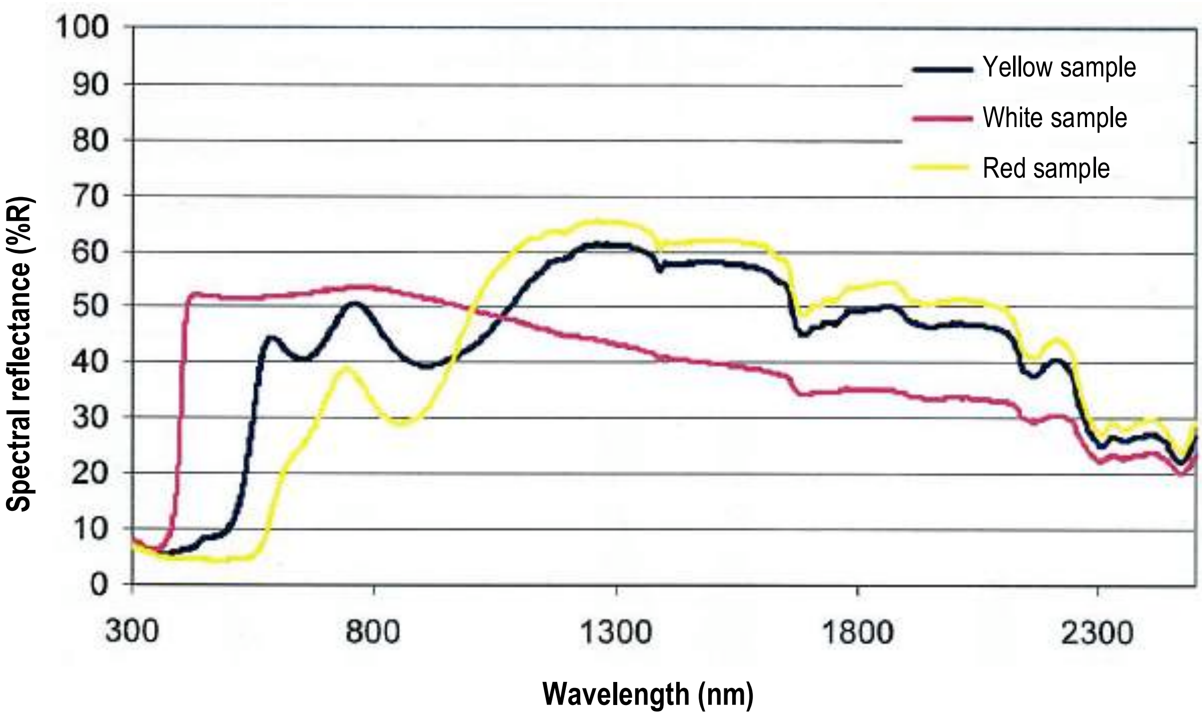


Fig. 4 The spectral reflectances of the studied samples, pooled

2.2 Calculation of solar reflectance

The spectral reflectance data were used to calculate the reflectance of each sample to sunlight. The term solar reflectance (SR) designates the total reflectance of a surface, considering the hemispherical reflectance of radiation, integrated over the solar spectrum, including specular and diffuse reflection.

The calculation was performed by weighted average, using a standard solar spectrum in accordance with ASTM E903-96 and ASTMG159-98.

Additionally, we calculated the reflectance of materials to the ultraviolet (SRUV), visible (SRVIS) and near infra-red (SRNIR) spectrum of solar radiation. The results are shown in Table 2. Figure 5 shows the solar reflectance values for the materials under study.

Tab. 2 Reflectance values of the samples (%)

s/n	Designation	SR	SRUV	SRVIS	SRNIR
1	Yellow sample	**39**	6	27	48
2	White sample	**47**	7	51	46
3	Red sample	**32**	6	12	46

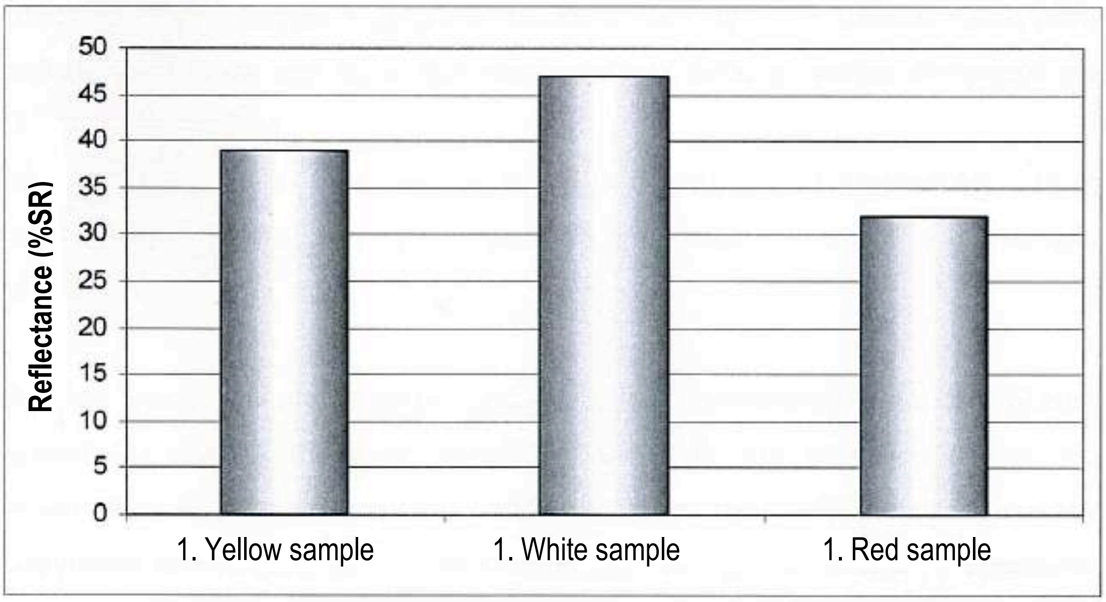


Fig. 5 The values of solar reflectance for each sample

2.3 Measurements of emissivity in the infra-red spectrum

The infra-red emissivity of each sample was measured in accordance with ASTM E408-71 (2002): Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques. Infra-red emissivity (e) determines the ability of a surface to emit energy as compared to a black body at the same temperature. For the measurements, we used the Devices & Services Emissometer model AE. This instrument determines the total emissivity index, compared with two standard materials of high and low emissivity. The results of the measurements are shown in Table 3.

Tab. 3 Total emissivity index values of the samples (%)

s/n	**Designation**	**Emissivity index (e)** (Error ± 0.02)
1	Yellow sample	**0.88**
2	White sample	**0.89**
3	Red sample	**0.86**

3. CONCLUSIONS

Table 2 and Figure 5 show that the largest solar reflectance is shown by the White sample 2, with an SR = 47%, while the smallest by the Red sample 3, with an SR = 32%. These results are confirmed by the spectral measurements, as shown comparatively for all materials in Figure 4.

The results of the emissivity index (e) measurements show that its values in all three samples are high, without significant differences between them.

The use of materials with increased solar reflectance and high infra-red emissivity index values reduces surface temperatures and thus the internal temperatures and the energy consumption of buildings, while it can help in managing the problem of heat islands and improving the microclimate of the city. (Doulos et al., 2004, Prado et al., 2004, Synnefa et al., 2006, Bretz et al., 1997).

4. REFERENCES

ASTM E903-96: Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres.

ASTM Standard Gl59-98: Standard Tables for References Solar Spectral Irradiance at Air Mass 1.5: Direct Normal and Hemispherical for a 37° Tilted Surface.

ASTM E408-71 (2002): Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques

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