Measurement of paper's surface structure

Choice of paper

Paper is one of the most commonly used mediums to transmit information. The quality of the paper used as the medium to transfer information reflects the choice of how the information is to be conveyed. The substantial differences in the type and quality of paper need to be understood before making a choice.

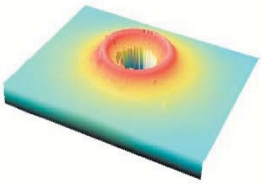
The differences of paper types are based on composition, colour, coating, and consistency. Another difference, the structure of the paper's surface, is critical to the impression and the stamping characteristics of the printed characters and images. The paper's surface structure can range from very rough to extremely smooth. The large degree of surface roughness variation causes frequent problems for printing systems. The measurement and characterization of the paper's surface structure then becomes an important task.

Paper surface characterization techniques with limited capabilities

Mechanical profilers attempting to characterize the paper's surface structure are not suitable for this application as their stylus tip mechanically interacts with the paper modifying the surface during measurement.

Point measuring sensors are far too slow and do not provide the necessary details to recognize variations in fibre structures hence making them unrelible as paper surface inspection sensors.

White light interferometers are effective surface measuring systems, but are not able characterize highly structured surfaces.



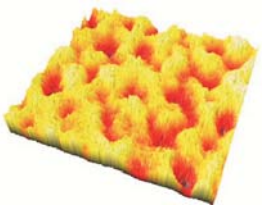
Glossy paper covered with plastic foil.

A new surface characterization technique

Sensofar has developed a new method to perform detailed characterization of the surface structure of a wide range of paper types.

Sensofar's Plμ 2300 Confocal Imaging Profiler includes the advantages of all the optical measuring techniques in only one tool.

Fig.1: Plμ Confocal Imaging Profiler

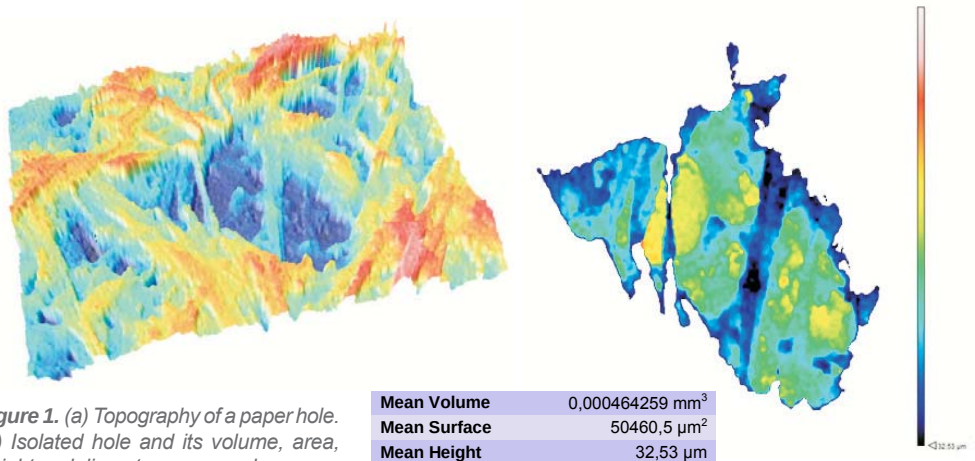


High quality, structured paper.

SENSOFAR®

Measurement of the paper holes

Envelopes and low quality paper, like recycled paper, have problems during the printing process. If the quantity of ink deposited on the surface is low, then some white or brown pits appear. To increase the quality,a higher amount of ink is used, increasing the printing cost. PLu 2300 offers the possibility to help inspecting the causes that produce this pits to appear. Figure 1 shows the 3D measurement of a surface hole were the ink does not enter due to superficial strain. The depth, area and volume is measured and used during the manufacturing process to reduce the number of them.

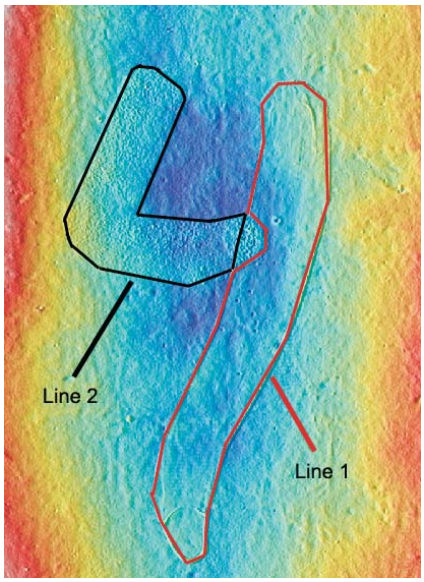


Mean Volume	0,000464259 mm^3
Mean Surface	50460,5 μm^2
Mean Height	32,53 µm
Equivalent Diameter	253,47 µm

Figure 1. *(a) Topography of a paper hole. (b) Isolated hole and its volume, area, height and diameter measured.*

Measurement on different types of roughness

There are studies about checks, affidavit or bank certificates that have been falsified by changing numbers or letters. For instance, it is easy to change a number 3 to a number 8 by drawing the left part on top of the right one. Even using the same pen, the texture and roughness on the superposition zone varies in comparison to the rest.



	Line 1 (µm)	**Line 2** (µm)
Sa	0.390203	0.590566
Sq	0.501074	0.760176
St	9.97475	6.88567
Sz	4.49595	5.26497

Figure 2. *The figure shows a forensic study. Number 4 was done with two different pens. The line 2 was made after the line 1. The table shows roughness parameters of two lines.*

Periodic structres of paper and roughness isolation

Paper usually has periodic structures called nets, which come from the fiber filter. There are also periodic structures made on purpose in some papers to get some particular effect, as in kitchen paper roll or presentation cards.

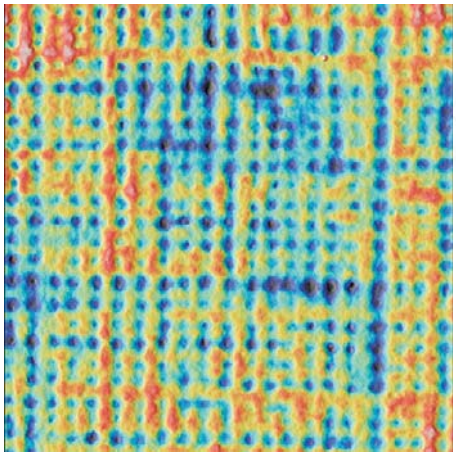


Figure 3. Presentation card topography.

The conventional system to measure paper roughness has been air pressure. The method consists on pressing the paper with an aluminum cylinder. As a consequence of the surface roughness the ring doesn't contact with the whole surface. Air pressure is applied at one extreme of the cylinder and part of this air escapes between the paper and the cylinder. As a result, the loss of pressure is an indirect measurement of the roughness.

On the other side, by using an optical profiler the measurement of the surface roughness is done directly. The main frequences of papers that hava a periodic structure can be removed digitally. This way the high frequency structure can be separated from low order components. The Fourier transform and parameters are calculated by SensoMAP.

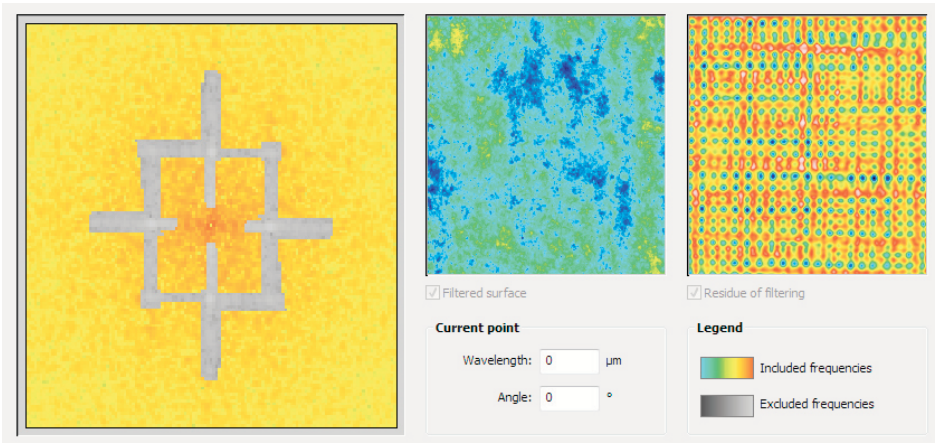


Figure 4. Filtering by direct edition of Fast Fourier transform by SensoMap .

Structure of the stamped master

Bank notes are marked with several lines so that the blind people can recognize different kind of notes. Marks are reproduced in one side of the note. Using SensoMAP it is possible to calculate average height and roughness of these marks, as well as the frequency by SensoMAP Frequency Spectrum.

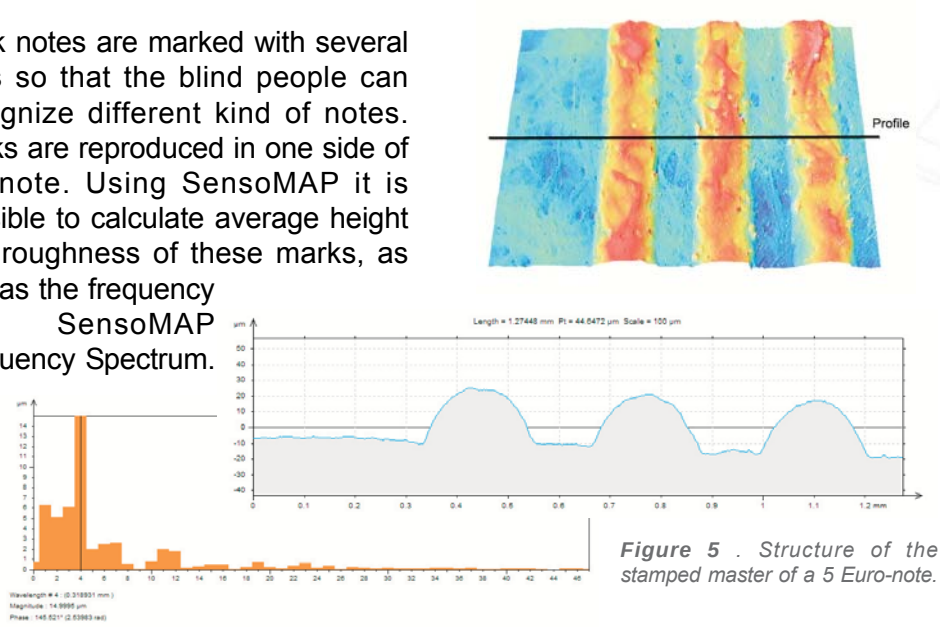


***Figure 5** . Structure of the stamped master of a 5 Euro-note.*

Roughness with different layers

It is possible to measure the surface of a paper when it is under pressure with a glass. The roughness of the surface will change when the paper is pressed. Using Collar Ring Adjustment objectives it is possible to profile a surface under a glass (up to 2 mm thickness). Figure 6 shows the surface texture difference of a piece of paper with and without glass pressure.

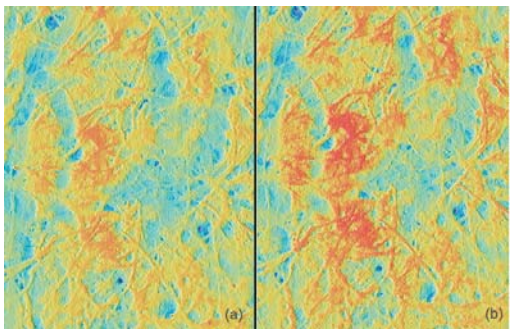


***Figure 6**. The topography (a) is a paper measured 20X and the topography (b) is the same paper where it has been applied pressure with a glass 2 mm thick. The 20XCR objective allows focusing through optical windows. The topography is measured properly through the glass.*

Technical specifications (*)

Measuring principle	Optical Imaging Profilometry (PSI, VSI and Confocal)
Measured fields of view	from 15x15 μm^2 to 10x10 mm^2 (larger FOV with stitching)
Capabilities	Image, 3D-Topography, Profiles, Coordinate, Thickness, Zoom function, Filters, etc
Objectives	From 2.5X to 150X
Maximum resolution	<0.1 nm (PSI) to <1 nm (Confocal)
Lateral resolution	down to 0.1 µm (with 150X0.95NA Objective)

(*) Further system information can be downloaded from www.sensofar.com

Sensofar-Tech, S.L.
Ctra. N-150, km. 14,5
Mòdul TR20 - IPCT
E-08227 Terrassa
T. +34 93 739 89 45
F. + 34 93 786 01 16
info@sensofar.com
www.sensofar.com

SENSOFAR®