RESEARCH OF PAPER SURFACE STRUCTURE WITH WATERMARKS

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PURPOSE OF WORK

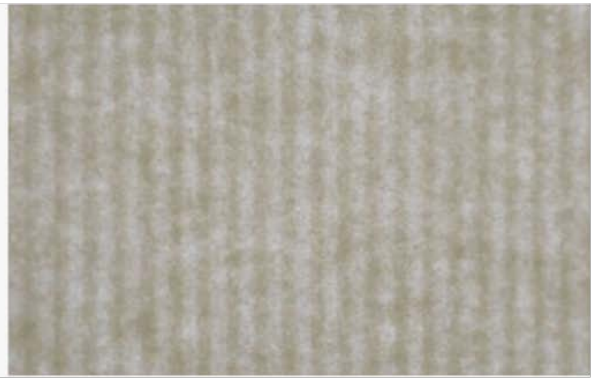
- **The purpose of this work is to research the roughness of different areas of paper with watermarks by method of profilometry**

EQUIPMENT AND MATERIALS USED IN THE WORK

- few types of paper protected with watermarks
- mixed inks for the offset sheet print
- proof press IGT
- profilometer with an inductive transformer (model 296)
- spectrophotometer SpectroEye (Gretag Macbeth)

Pictures of paper samples

a



b

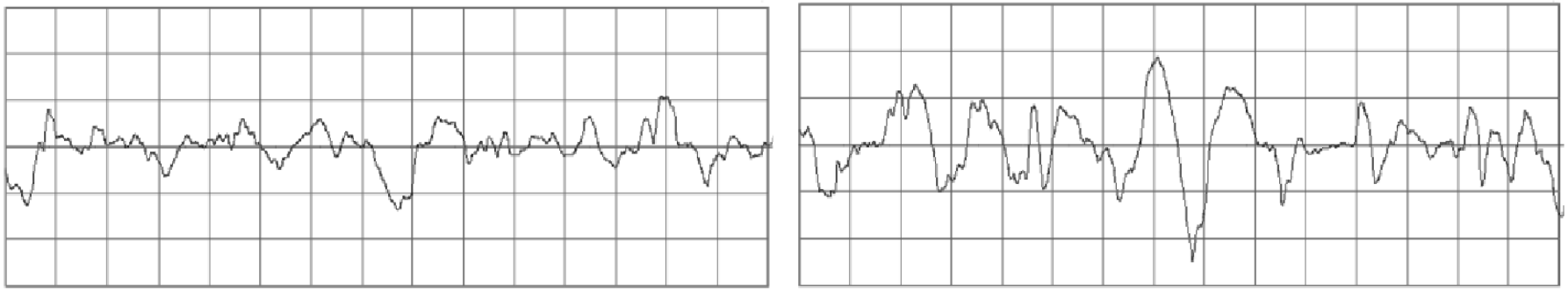
c

- ***a*** – sample №*1 Security lune*: color is white milk; watermark is a "half moon";
- ***b*** - sample №*2 Filidoro of laid avorio*: color is ivory; watermark is a "strip“
- ***c*** - sample №*3 Chestnut* (with ink): color is white milk; watermark is a "Chestnut flower“

Descriptions of select types of paper

№	Name of paper	Presence of optical brighte-ners / protective fiber	White-ness, %	Opa-city, %	Smoothness, (Bekk), s		Absorb-ency, Kobb	Mass, g/m2
					Wire mesh side of paper	Face side of paper		
1	Security lune	- / +	79,3	85,6	28	29	27	90
2	Filidoro laid avorio	- / -	72,7	86,2	9	13	18	80
3	Chestnut	- / +	77,9	85,1	19	21	23	90

Surface profilograms of sample №1 Security lune (Frontside of paper; no ink)



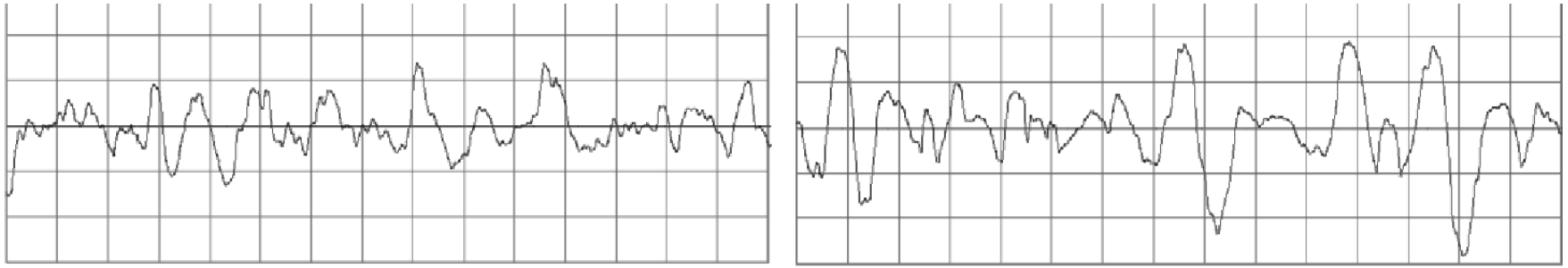
- ***a*** – the area without watermarks

(Ra=1.541; Rz=1.041; Rmax=11.566; S=0.015)

- ***b*** - the area with the negative watermark

(Ra=2.883; Rz=1.982; Rmax=20.010; S=0.018)

Surface profilograms of sample №1 Security lune (Netside of paper ; no ink)



а *б*

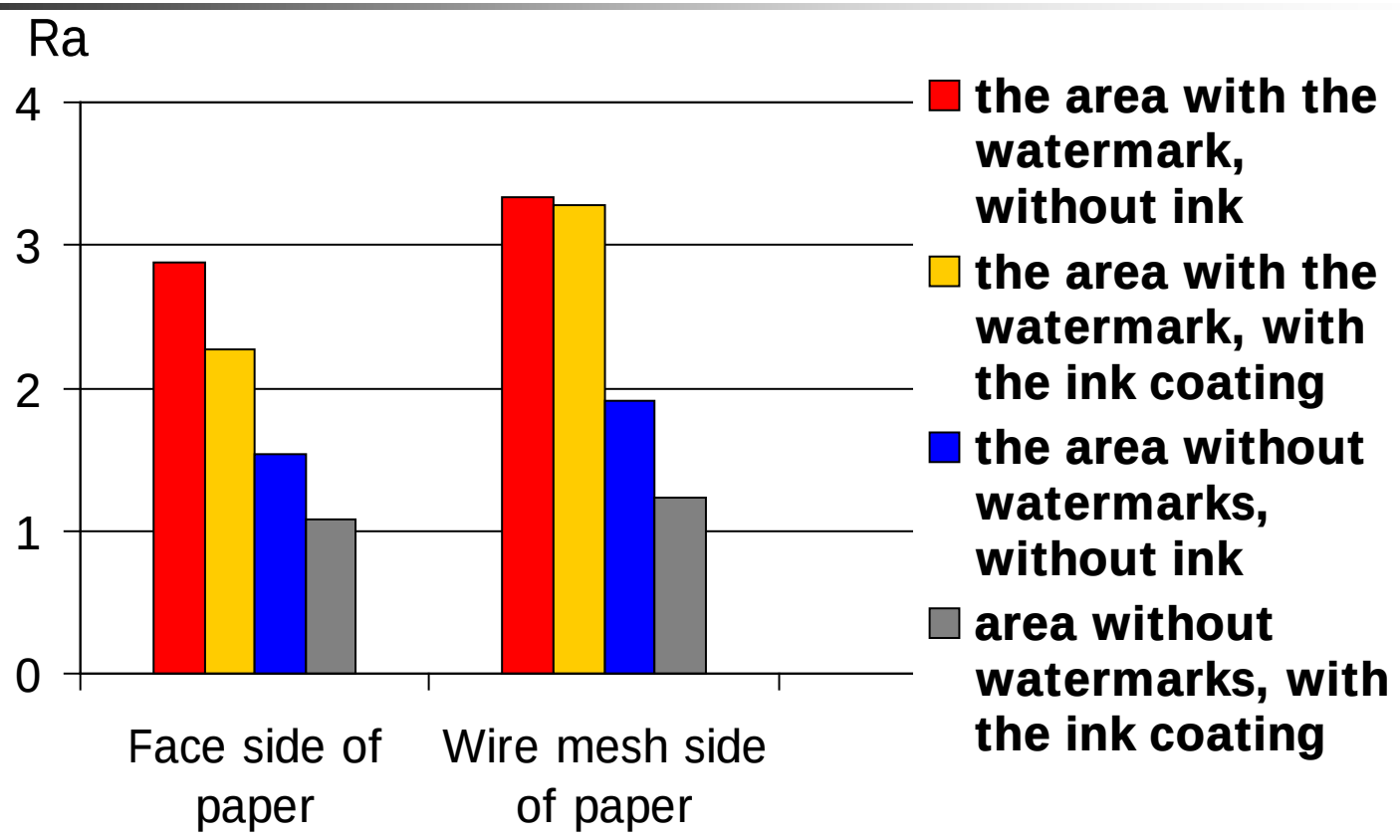
- ***a*** – the area without watermarks

(Ra=1.906; Rz=2.495; Rmax=12.591; S=0.017)

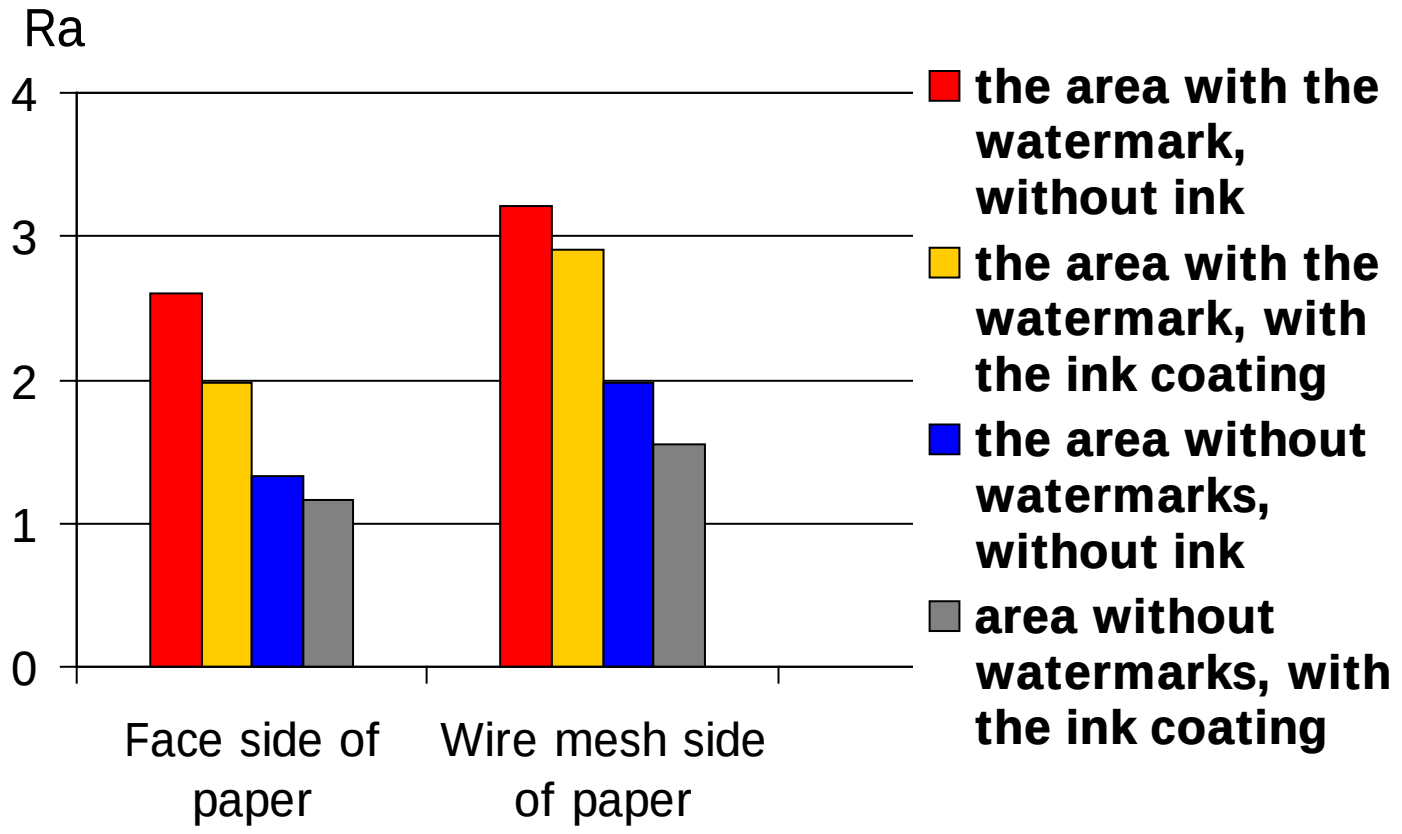
- ***b*** - the area with the negative watermark

(Ra=3.334; Rz=3.039; Rmax=20.974; S=0.020)

Diagrams of paper roughness (sample №1 Security lune)



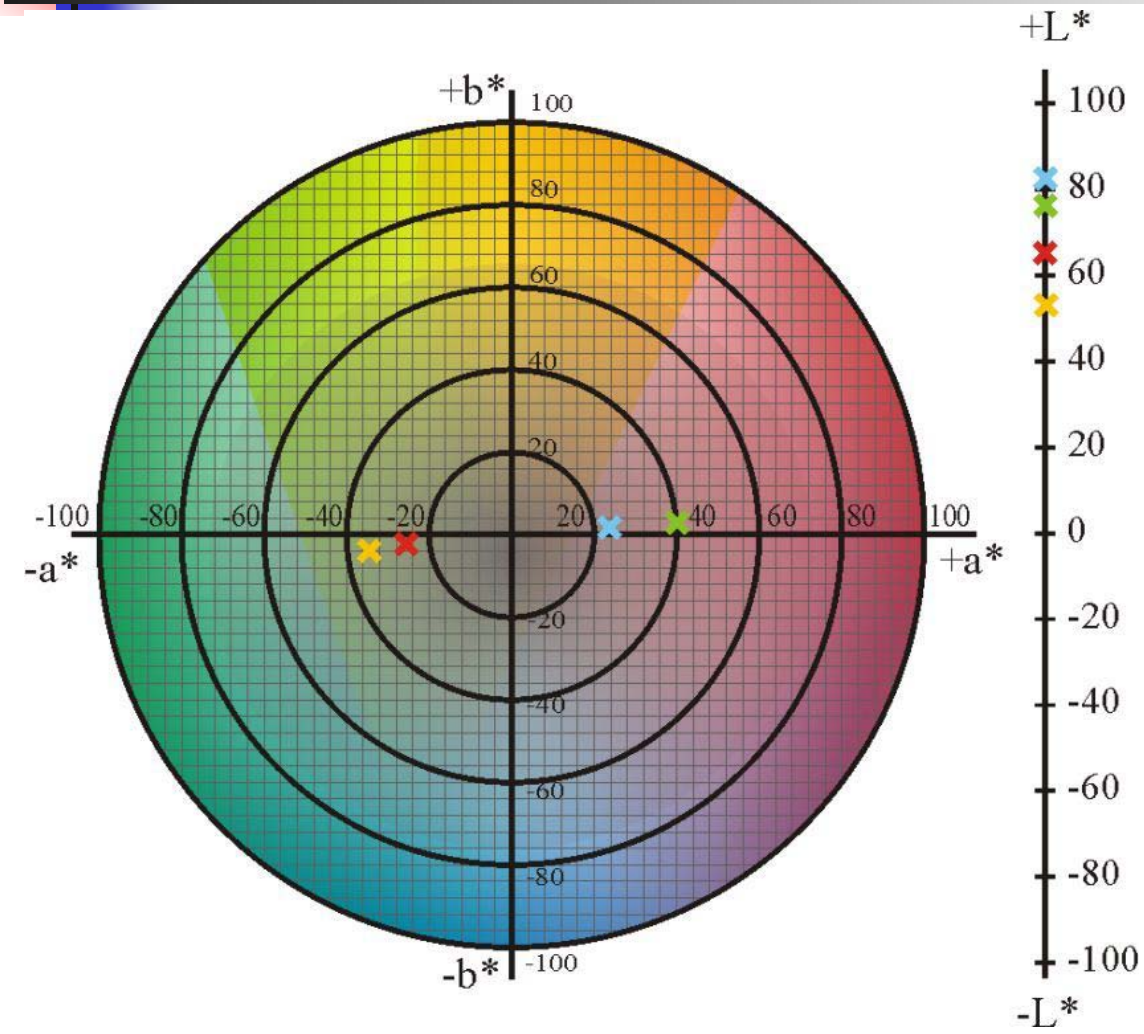
Diagrams of paper roughness (sample №2 Filidoro laid avorio)



Color characteristics of different parts of the paper №3 Chestnut

The ink number	Thickness of the ink layer, μ	Part of the paper	L*	a*	b*	D	Δ E between parts of the paper with watermark and without it
№ 327	0,66	watermark	52,31	-36,83	-3,68	0,5	16,07
		plain paper	64,4	-26,29	-2,76	0,35	
	0,92	watermark	50,26	-38,31	-3,79	0,53	9,74
		plain paper	57,33	-31,64	-3,10	0,44	
№ 190	0,56	watermark	72,78	40,47	1,49	0,56	18,90
		plain paper	81,62	23,76	1,32	0,32	
	0,65	watermark	70,34	43,89	1,74	0,62	14,70
		plain paper	77,65	31,16	1,00	0,42	

Coordinates of colors in the CIE L*a*b* system



- the ink № 327; area with a watermark
- the ink № 327; area without a watermark
- the ink № 190; area with a watermark
- the ink № 190; area without a watermark

Conclusions

- The value of roughness on the different areas of paper differs substantially (on the areas with the negative watermarks the roughness value is maximal, and on the positive ones – minimum; a roughness decrease on the samples with the printed ink).
- ΔE (color distinction) between different parts of paper is very substantial.
- Insufficiently saturated color in the areas of negative watermark evidence "falling through" color pigment deep into the paper. Large color saturation in areas of positive watermarks, evidence of a significant amount of pigment on the surface of paper, which is explained compaction of paper structure in this area and porosity decreasing.

Thank you