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STATISTICAL ANALYSIS OF THE INFLUENCE OF PRINT RUN ON SURFACE ROUGHNESS OF DIGITAL FLEXO PRINTING PLATES' SOLID TONE AREAS

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Introduction

Flexography is a direct printing technique primarily recognisable due to its exceptional ability to print on the various substrates delivering high quality imprints. Due to its cost effectiveness, versatility and efficiency, it became growing printing process on a highly demandable graphic arts industry market.
In light of ink transferring, especially from the large solid areas which are not rare in flexography, the controlled and uniform ink transferring from the printing plate onto the printing substrate is a must if the high-quality output is a goal. One of the parameters which are directly linked with the ink transferring rate is printing plate surface property. The analyses of surface topography give relevant information to make possible prediction of behaviour of the flexo plate surface during printing process. Moderate surface roughness of flexo printing plate is desirable since it enables optimal ink transfer, while excessive roughness of the solid areas cause low solid ink density due to failure to make contact between the printing plate surface and a given substrate. Too low surface roughness may lead to again insufficient ink transfer onto the printing plate.
In this paper we have explored the influence of print run on changes in surface roughness of solid tone areas on three sets of CtP flexo printing plates consisting of cyan, magenta (process colors) and blue (spot color) plate. The first set represents the CtP flexo printing plates that were not used in printing process, the second one consists of printing plates that were used for printing of 53075 meters of printing substrate, while the third set represents flexo plates used for printing the 82025 meters of the substrate. The obtained data were compared by applying independent-samples t-test in software SPSS (Statistical Package for Social Science, version 20) with a 0.05 significance level.

Methods

For the purpose of the experiment, printing plates were processed according to manufacturer's recommendation. During the experiment, 17 cardboard rolls, or 82025 meters, were printed with the same printing plates. The sampling was done at the beginning of the print, after 11 and after 17 printed rolls. The measurements were done on the solid tone area of each prewashed printing plates. Amplitude surface roughness parameters, Ra, Rp, Rv and Rz, were measured at 11 positions, in printing and cross printing direction, whereas 32 measurements for each parameter was used for further statistical one factorial ANOVA analysis in SPSSv20 statistical tool. For the surface roughness measurements, we have used hand held portable stylus roughness tester TR 200: cut-off 0.80 mm, sampling length 5xcut-off, Gauss filter, resolution 0.01 µm, measuring speed Vt= 0.5 mm/s. In results presentation, the values measured from the printing plates before printing, after 1 and 17 rolls, will be noted as 1, 2 and 3, respectfully.

Results

Table 1
Surface roughness parameters of three flexo plates (cyan)

	Plate	Average value (µm)	Std. Dev.	Koef. of variation (%)
Ra	1	0.083	0.014	17.05
	2	0.082	0.048	12.24
	3	0.073	0.010	13.72
Rp	1	0.216	0.042	19.61
	2	0.223	0.048	21.54
	3	0.210	0.034	16.24
Rv	1	0.222	0.049	21.88
	2	0.213	0.034	15.90
	3	0.183	0.036	19.48
Rz	1	0.438	0.041465	23.33
	2	0.436	0.056480	16.45
	3	0.393	0.064211	14.62

Table 2
Surface roughness parameters of three flexo plates (magenta)

	Plate	Average value (µm)	Std. Dev.	Koef. of variation (%)
Ra	1	0.079	0.012	15.56%
	2	0.077	0.007	9.61%
	3	0.071	0.015	21.49%
Rp	1	0.291	0.071	24.37%
	2	0.246	0.052	21.01%
	3	0.213	0.045	21.34%
Rv	1	0.206	0.041	20.02%
	2	0.204	0.034	16.78%
	3	0.177	0.043	24.04%
Rz	1	0.496	0.101	20.37%
	2	0.450	0.073	16.17%
	3	0.390	0.092	23.66%

Table 3
Surface roughness parameters of three flexo plates (blue)

	Plate	Average value (µm)	Std. Dev.	Koef. of variation (%)
Ra	1	0.080	0.008	9.81
	2	0.076	0.010	13.55
	3	0.072	0.013	18.11
Rp	1	0.185	0.039	21.03
	2	0.202	0.030	14.74
	3	0.240	0.046	19.00
Rv	1	0.217	0.034	15.56
	2	0.202	0.021	10.32
	3	0.181	0.035	19.45
Rz	1	0.402	0.065	16.10
	2	0.405	0.072	17.85
	3	0.421	0.079	18.69

Table 4
Independent-samples t-test (cyan)

Independent Samples Test							
			t-test for Equality of Means				
	Partial Eta squared (η^2)	Sig.	t	df	Sig. (2-tailed)	95% Confidence Interval of the Difference Lower	Upper
Ra	0.002	.062	.327	62	.745	-.005107	.007107
Rp	0.002	.003	-.382	62	.704	-.040124	.027249
Rv	0.012	.551	.868	62	.389	-.011840	.030027
Rz	0.000	.017	.120	62	.905	-.041468	.046781

Table 5
Independent-samples t-test (magenta)

Independent Samples Test							
			t-test for Equality of Means				
	Partial Eta squared (η^2)	Sig.	t	df	Sig. (2-tailed)	95% Confidence Interval of the Difference Lower	Upper
Ra	0.163	.779	3.473	62	.001	.003686	.013689
Rp	0.008	.015	.688	62	.494	-.024465	.050152
Rv	0.098	.022	2.596	62	.012	.006876	.052936
Rz	0.047	.022	1.758	62	.084	-.005860	.091360

Table 6
Independent-samples t-test (blue)

Independent Samples Test							
			t-test for Equality of Means				
	Partial Eta squared (η^2)	Sig.	t	df	Sig. (2-tailed)	95% Confidence Interval of the Difference Lower	Upper
Ra	0.139	.045	3.168	62	.002	.003575	.015800
Rp	0.001	.949	.290	62	.773	-.037781	.050593
Rv	0.126	.187	2.985	62	.004	.012881	.065119
Rz	0.042	.762	1.650	62	.104	-.009620	.100432

Discussion / Conclusion

In this paper detailed statistical surface roughness analysis of CtP flexo plates in correlation with print run was conducted. The conclusions derived from the conducted research are as follows:

- The changes in values of four amplitude surface roughness parameters (Ra, Rp, Rv and Rz) due to print run, obtained by the by direct stylus profilometric method, generally correspond to anticipated trend: longer print run will result in lowering the surface roughness of the flexo printing plate.

- The decreasing tendency is clearly expressed through changes of the average surface roughness value – Ra: the differences between average Ra values at the beginning of the printing and after 82025 meters of printed material were found to be statistically different in case of all printing plates utilized in the experiment.

- On the basis of values obtained for more specific surface roughness parameters – peaks and valleys (Rp, Rv and Rz), it is seen that the longer print run will, generally lead to in wearing the profile peaks and lowering valleys depth. The contradictory result was obtained only in case of Rp and Rz values for the printing plate for blue spot color. The noticed increasing tendency, may indicate that the abrasive nature of printing inks or substrate may lead to micro damages on the flexo printing plate surface which might be detected as profile peaks.

- Values of partial eta squared points out the mild to high influence of print run on the changes in surface roughness of digital flexo printing plates.

- The statistical analysis reveal that the influence of print run on changes of the peak and valleys surface roughness values may not be in case of all printing plates considered as statistically significant. This might be connected with the type of ink used (process vs. spot colors) and its characteristics in terms of granulation and influence on the printing plate surface.

- With further analysis, extended on other printing substrates and inks, as well as printing plates in terms of processing parameters, this research can be significantly upgraded and may deeply reveal the changes in surface roughness on the CtP flexo printing plates in dependence of print run.

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