RELATIONSHIPS BETWEEN THE SURFACE TEXTURE OF FLEXOGRAPHIC PRINTING PLATES AND THE PRINTABILITY OF KRAFT PAPER

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ABSTRACT

This paper explores the solution to a genuine problem – to find an answer on how to obtain the best results of printing on brown kraft paper using flexographic printing. Over the past two decades, the production of flexographic printing plates has evolved rapidly. With the development of digital platemaking, flexographic printing has advanced greatly. The newest technologies in platemaking work with flat top dots where the absence of oxygen at the main exposure is essential for the technology to work. The main aim of our research was to find out the best way of producing flexographic plates to ensure the best quality printing on brown kraft paper. Plates from the largest suppliers were used. Nine raw materials were chosen to carry out the research and to explore which of them would work on this carrier. The plates were processed with the Esko Pixel+ software solution, which is able to alter the surface structure of printing plates through specific microcell structures. For the later steps of the plate production we used the DuPont™ Cyrel® Digiflow technology. Afterwards, a certified X-Rite photospectrometre was used to measure the print test samples. Finally we present the best results for printing on brown kraft paper.

Keyword: flexographic printing, kraft paper, printing plates, flat top technologies.

1. INTRODUCTION

Andy Kannurpatti, Marketing Manager at DuPont Packaging Graphics in the US described in one of his articles – based on the surveys of DuPont – what it was that customers and printers needed the most. The results definitely showed that it was production efficiency and compliance with the quality requirements. Naturally, this can only be provided if stable and high-quality printing forms are used.

The choice of the topic was inspired by the fact that in Western Europe – and increasingly in Central Europe as well – food products made from organic or natural raw materials, as

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well as artisan products are often packaged in plain brown or white paper without prints, or in printed, coloured kraft paper packaging material. Flexo printing shops receive a growing number of orders where the product needs visual emphasis, or plain packaging is requested because of unique graphic styles. In this case, kraft paper offers the best solution.

Each day we are also faced with special tasks: finding the optimal solution – making the right printing plate – for printing on a difficult material. Due to its structure, brown kraft paper is included in the more problematic topics.

During the last 2 decades there was considerable progress in the field of making the printing plates. Flexo printing has reached a level where packaging materials made with flexo printing can compete with even the rotogravure printing of packaging materials.

The choice of the topic was inspired by the possibilities and the challenges, with the purpose of examining the responses (in respect of printing parameters) of printing plates's surface roughening structures created with the use of the modern processes, and at the same time focusing on finding the best printing results when flexo printing on this material – kraft paper – that is increasingly popular in the packaging industry.

This article examines the various possibilities of achieving surface roughness when making the printing plates, and then, based on the results of our examination, we intend to show the methods for achieving the best printing results on brown kraft paper.

2. MATERIAL AND METHOD

The development of making flexo printing plates has been exceptional in the last two decades, and these days flexo printing is one of the leading printing technologies.

In his article about the milestones of making flexo printing plates, Péter Ratkovics provided an excellent summary – in just a few sentences – about the history of making flexo printing plates.

"Flexo printing has achieved top position among the printing processes used in the field of packaging technology. Although the technology has its roots in the late 1800s – since Rubber Print, the first flexo process was patented in 1890 in the US – the real breakthrough arrived only one hundred years later.

2.1 The road to today's advanced processes of making printing plates

The critical point of flexo printing has always been the printing plate, but the photopolymer plates used today for quality printing were first marketed as late as in 1974 by DuPont; then digital flexo printing plate making presented the first Cyrel digital photopolymer plate and the first Cyrel Digital Imager (CDI) at the 1995 Drupa Exhibition. This is the moment where the conquest of flexo started ...." (Ratkovics, 2011)

In the same article we can read about the beginning of making printing plates for flexo printing. Digital printing plate production began in the 1970s, in the form of direct laser engraving. However, the technology was not perfect and it encountered a number of limitations; there was a problem with extracting the engraved residues and with low productivity. Devices using this procedure are still manufactured today, but only a few of them are sold each year.

Based on our current experience, there is relatively low interest in printing plates made with the process of direct laser engraving. Endless elastomer sleeves are made in this way; however, the relatively long production time and the roughly 4–5 times higher costs discourage printing presses and customers alike from using these endless rolls. While classic flexo printing plates are made within 3–4 hours from the time of the order, it takes 2 weeks to manufacture an endless elastomer roll. The sleeves in the printing process also react in ways different from photopolymer sheets, making the work of printers harder.

"Therefore, this type of plate making for flexo printing did not prove to be the right one. Today's modern flexo was brought to life by the researchers of Basel-Scheel company (Ratkovics, 2011).

They started working on digital photopolymer plates in 1990, and their result was finally patented in 1993. The first CDI was presented at the 1995 Drupa Exhibition; in the same year Basel-Scheele was acquired by Barco Graphics, which was one of the predecessors of Esko. As it is known, CDIs are among the market-leading equipment when looking at installation, and as it is mentioned in the article by Péter Ratkovics, over 90% of flexo plates are made with the use of CDI technology, and the market share of the sold equipment is over 70% (Ratkovics, 2011).

The making of analog polymers (using films) was continuously replaced by a digital process in the 90s.

Digital flexo plates are made on the principle that there is a black mask layer covering the photopolymer plate, and the laser burns into it the pattern to be printed – practically the mask is burnt at the printing points. After the motive to be printed is created by the laser, the main exposition starts the polymerization process. At the points where the LAMS layer was burnt off, the UV light enters the plate and polymerizes the material. Technologically this was a big improvement, since the contact of the film and the analog plate cannot be completely perfect, and therefore – due to the UV light dispersion – the geometry of the printing points is also different from digital plates. Low light dispersion is ensured by the LAMS layer, so the laser can work with much smaller and more precise motifs.

Results that were difficult to achieve with analog plates worked well with digital plates. It became possible to print smooth gradients and points with a few percent value with the use of flexo as well, following the register setting of multi-coloured prints became more accurate, and dot gain was also decreased significantly. The steps following exposure remained the same as in the analog method of making printing plates, so washout, drying and post-exposure can be used just like in the case of analog solvent platemaking.

These devices have been continuously modernized, and what is more, if the chemical structure of the washout liquid is selected appropriately, on the one hand solvent platemaking can be made more environmental friendly, and on the other hand the washout liquid also influences the production time – modern washout liquids ensure shorter platemaking time. Figure 1 shows – using simple illustrations – each step of making digital flexo printing plates.

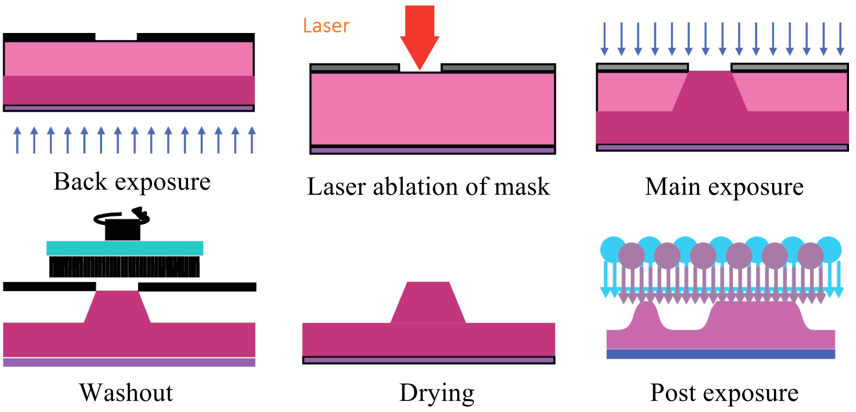

Figure 1: Steps of making digital printing plates (source: DuPont)

At the end of the 2000s, there was another leap in the upward career of flexo: HD flexo. The developer once again was Esko. The essence of the new technology was to increase the resolution to 4000dpi (the first digital CDI used 2100dpi, so resolution was now almost doubled), making it possible to form much smaller printing points on the plates – and in this way making printing points as small as 6 microns. Another part of the development was the use of special screens and various microcells. Due to all the above developments, in addition to the high number of advantages, flexo had nothing to be ashamed in terms of quality, since tasks converted from offset and rotogravure printing could be flexo printed without loss in quality.

After that, only a few technological development steps were necessary to reach the modern top technology as we know it today, making flexo printing one of the leading printing technologies today.

2.2 Procedures for roughening the surface of printing plates

Roughening the surface is an integral element of contemporary printing plate production. Pixel+ technology was developed by Esko Artworks, in order to improve flattop platemaking technologies. Various screen structures and microcell procedures were developed in order to raise the ink transfer level of printing plates, and to increase solid ink density (SID).

The Pixel+ technology may be applied in several flattop platemaking systems, such as DuPont Cyrel® Digiflow, MacDermid LUX and Flint Nyloflex® NExT systems. In order to incorporate the Pixel+ technology in the production processes, software and hardware development is also necessary – HD-flexo development is incorporating the new screen and microcell structures into the workflow, and as for the hardware, appropriate optics is necessary for the CTP equipment, and Grapholas software as well.

Due to exposure in oxygen-free environments, flattop microcells can be much smaller, in this way optimizing ink transfer. These extremely fine structures can be transferred to the surface of the plate with the use of certain technological developments, such as:

Improving the optical components of the CTP equipment
Special laser structure (multibeam)
Other hardware and software functions

The accuracy of exposure can be increased with the use of special optics and laser beams, while the third element works with the special structures. The screen structures and microcell methods used by Pixel+ realistically cannot be graphically created in a program. The Grapholas software serves to analyze .tif extension files – used for the laser expose of the printing plates – and to recognize the structures, then to expose the plate. Such structures are for example: MCWSI, MG34, or MG45. Not only the structures are specific, but the principle of operating the laser as well. Adjustable laser power assists in making the appropriate structure on the surface of the printing plate. During the test setting the laser power can be set from 100% to 250%, by 10%. This means that Grapholas finds the structure, the point it has to expose, and does it at the set laser power – in this way modifying the microcell to be created.

As it has been mentioned, our goal is to possibly increase ink density for printing. The right printing plate is of immense help for all raw materials, especially in case of ones with problematic material structure. Figure 2 shows a comparison of differences in density, depending on the surface treatment of the printing plates.

The illustration is intended to illustrate that, in case of four-colour printing under standard conditions, with solvent ink on polypropylene film, the density that can be achieved with standard digital plates is around 1.2. Minor improvement (about 1–1.5) can be achieved with the use of traditional microcells, but with the use of Pixel+ structures, ink density can be increased substantially: it can be increased by as much as five tenths, although the same printing press, the same ink, and the same printing plate base is used.

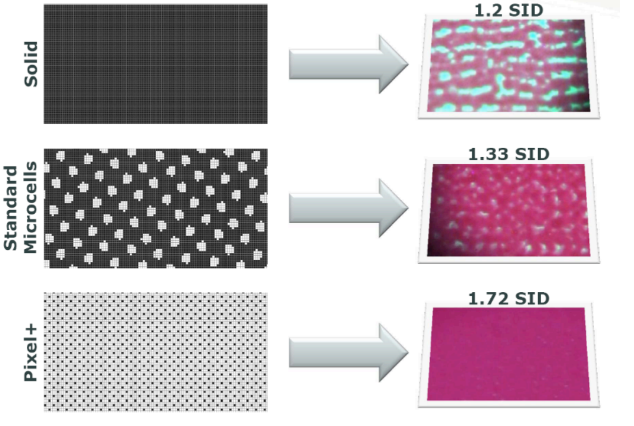

Figure 2: Ink density depends on the surface of the printing plate

The printing plate making technology that we have examined and compared to standard printing plate making, is more complex. In case of other plates made with standard procedures, the result does not depend so much on the ink transfer roll we use, than in the case of plates made with using the Pixel+ and Digiflow technologies. Naturally, there are advantages and disadvantages as well. A major advantage is – and in our opinion this is what distinguishes it from other printing plates – the exceptional print quality: perfectly covered tones and beautifully printed highlights. The only disadvantage is that in case setting is not performed perfectly, the result may be worse than in the case of a standard printing plate. Good results require setting the appropriate point sizes, structure, laser power, etc. for the specific ink transfer roll.

Regarding printing plate making, the cardinal point is setting the perfect laser power. As it has been mentioned earlier, the laser of the CDI can operate at various powers. This range can be set between 100% and 250%, by scales of 10%. The point sizes of Pixel+ structures can be modified by setting the laser power. The operating principle is that the higher is the power used for exposing one point of the Pixel+ structure, the greater printing point is achieved. This is not really printing point, but rather a kind of surface roughening – under multiple zoom of the flexo printing plate, it looks like the back of a hedgehog. Obviously, to the naked eye, there is no difference...

The difference in laser power can be best tested with the use of the test strips designed for this purpose. The test plate prepared for this purpose is called step test (Figure 3).

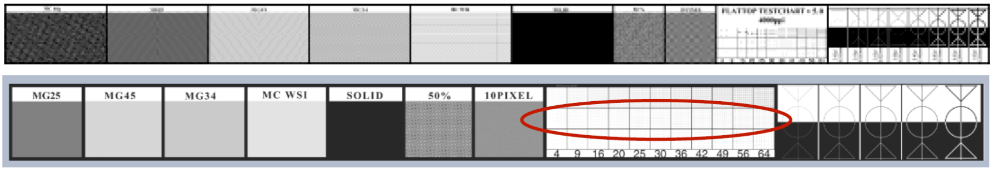

Figure 3: Test strip of the so-called step test

The step test shows the optimal laser power and structure. In most of the cases the step test produces a print result as shown below. Usually it is printed in colour cyan or purple. There is no need to worry if one or two fields are not printed properly – this phenomenon is perfectly normal for this test (Figure 4).

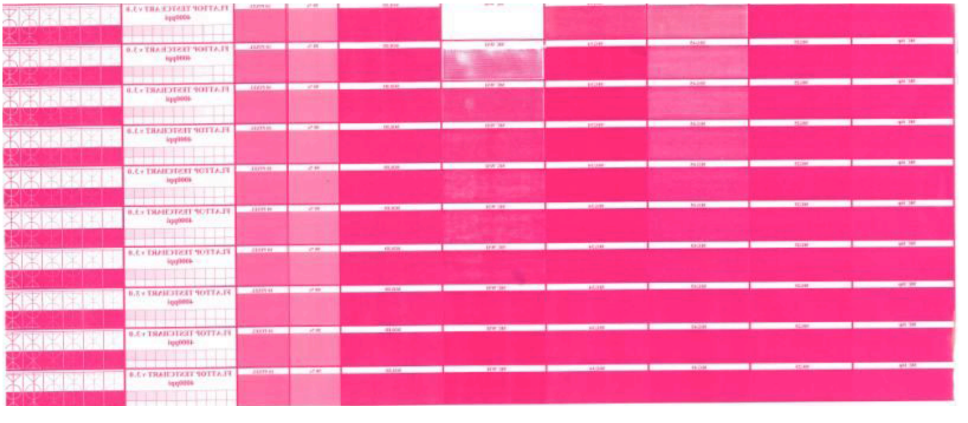

Figure 4: Printed step test

Viewed from left to right, you can see the following elements. Far left, there are the positive and negative elements. It is important to know the optimal or minimally necessary positive and negative line thickness for ink transfer, so that it will appear on the specific print as required. The second part is called the dotfail test, with the purpose of showing the minimum point size for the specific anilox roll. It is known, that in case the printing point size is smaller than the cup of the ink transfer roll, it will fall into the cup, and therefore ink transfer will not be proper. This is how C value – minimum point size – is received, ranging between 4 and 64. Naturally, the major part of the step test consists of the matrix of the structures and the laser power. The laser power applied is displayed in the lower left corner of the test strip.

The fields next to each other in a line contain the structures, while the fields from top down contain the various laser power levels. When evaluating the test, look for the richest and the most homogeneous field – it will provide information on the structure to be used for each laser power for the specific printing plate, in order that the surface finish of the printing plate will optimally match the selected ink transfer roll power, and in this way to achieve perfect results.

3. FINDINGS

Testing was conducted on a number of different plates. One of them was the ACT D raw material from Flint Group. ACT is a smooth digital, however, rather soft plate for its thickness of 1.14, making it a good base for perfect printing results. This was also demonstrated by the test sample.

We tested nine different raw materials. These were the products of three different platemakers – DuPont, Flint Group and MacDermid – with different characteristics and hardness.

Within the framework of this article – due to limitations of length – we only intend to comment on the raw material and setting providing the best results in the test. In addition to subjective optical control, the measured fields of the samples were also measured with densitometer, in order to determine the location of the largest increase in density compared to standard tone. As a result of these measurements, higher density is measured even in the case of the smooth – not microcelled – fields; therefore, this raw material is more suitable for making printing plates for the printing of kraft paper, than any other similar plates. In addition, this plate type also works well with Pixel+ and Digiflow manufacturing processes; it can be observed that density results in certain fields were over 0.21. MC16p structure – and although it is rather homogeneous, it lags behind the other types in density. MG25 produces good results at low laser power, but this type of structure can only be used for full tones – although at some places roughening the surface may be necessary even over 60–70%. MG34 and MG45 also showed an increase in density, however, MCWSI structure is the one producing the expected result. Due to its design, the laser direction of the plate does not matter, and with this Pixel+ structure we could achieve the highest density as well. Out of the samples this is the smoothest one, that is, good density results can be expected when examined with a microscope. Since in our opinion it is best to have the same or similar results in at least 3–4 consecutive fields, in real-life production MCWSI structure is recommended with 180% laser power. It is important to follow since – although CDI performance is balanced, as proven by daily tests – a certain safety factor needs to be taken into account, allowing for any fluctuations in laser performance. However, where the results of the 160% and 190% power of the selected structure and performance are similar or close to each other, there is no need to be concerned about making a bad quality printing plate.

An over 0.2 increase in density may be sufficient for producing prints on brown kraft paper in acceptable quality. Printing on paper has lower density than for example in the case of lay-flat film, but in the case of this raw material the value is at least near the adequate range.

The following table lists the density values measured on the print samples, with the use of spectrophotometer.

Table 1: Density results of using ACT D plate

	Solid	MCWSI	MG34	MG45	MG25	MC16p
100%	0.75	0.70	0.85	0.60	0.90	0.75
110%	0.75	0.73	0.83	0.62	0.87	0.73
120%	0.75	0.76	0.84	0.64	0.80	0.72
130%	0.75	0.82	0.83	0.66	0.75	0.71
140%	0.75	0.84	0.79	0.76	0.74	0.71
150%	0.75	0.88	0.80	0.78	0.78	0.69
160%	0.75	0.92	0.81	0.79	0.78	0.72
170%	0.75	0.94	0.76	0.80	0.70	0.69
180%	0.75	0.96	0.78	0.77	0.80	0.69
190%	0.75	0.96	0.78	0.76	0.78	0.71
200%	0.75	0.83	0.74	0.75	0.78	0.66
210%	0.75	0.83	0.76	0.76	0.77	0.70
220%	0.75	0.80	0.76	0.75	0.79	0.71
230%	0.75	0.78	0.72	0.74	0.74	0.68
240%	0.75	0.77	0.76	0.76	0.74	0.64
250%	0.75	0.77	0.77	0.74	0.74	0.65

These days very modern and custom made measuring devices are available for checking the making of printing plates. A device manufactured by the Peret company was used for the checking, which is suitable for evaluating the so-called mottle effect. This property provides further information. Mottle effect actually means smaller uneven parts in density, with fluctuation of density within a small area. This phenomenon is similar to the surface of the orange peel. In the case of prints, the lower the occurrence, the more beautiful and smoother the result is. In the photo taken by the measuring device, we can see the ink gain, and even the fibers of the paper.

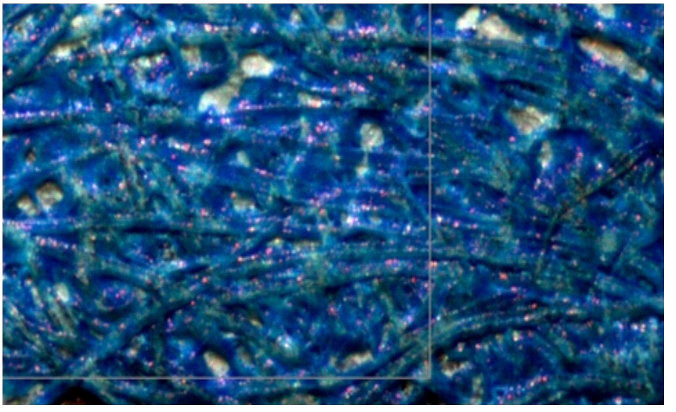

Figure 5: Macro photo of the paper surface and the applied ink

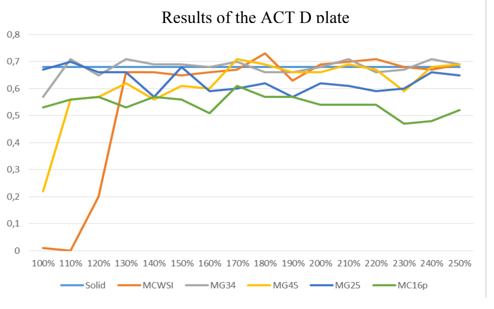

Figure 6: Step test displayed in a chart

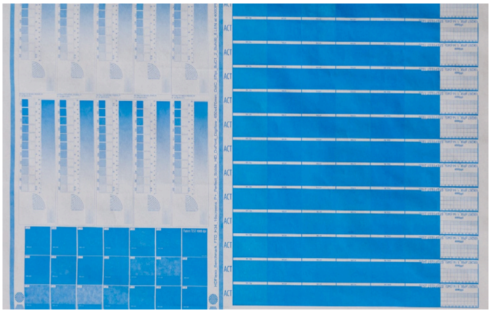

Figure 7: The “winner” sample

4.DISCUSSION, CONSENSUS, AND SUGGESTIONS

Therefore, it can be concluded that – with the use of the raw materials and software available in this situation – this is the best solution for printing plates we can recommend. The raw material itself is a problem area; however, it is also a challenge that must be faced. Printing on foil or coated flat paper is much easier; however, in case there is need for printing on brown kraft paper, then this is the task printing presses and their suppliers must resolve. In our opinion this task has been resolved successfully, since the CMYK colour profile test provided optically acceptable results (Figure 8).

Figure 8: Image of CMYK colour profile test

Our article was titled: "Examination of Correlations between the Surface Structure of Flexo Printing Plates and the Printability of Kraft Paper Used in Packaging Technology". Our goal was to find the optimal settings for making printing plates with the available devices, in order to achieve the optically best possible print results when printing on brown kraft Paper.

In this article we primarily used and referenced the publications of leading Hungarian experts. During the tests, we tried to incorporate as much practical experience and aspects as possible, since conferences and related white papers are intended for transferring knowledge usable for the profession.

Relying on the guidelines annexed to the technologies, we set up the test sequence and background. We discussed in detail in the Pixel+ technology, which includes an endless array of combinations. It is important to be familiar with the raw materials suitable for making printing plates, since their properties greatly influence the results of printing. Among the countless types of 1.4 mm thick raw materials there are suitable ones for almost all carriers, but you cannot always make your decision on the basis of the manufacturer's recommendations, but also on practical experience. The examination was based on the results of density measurement performed with spectrophotometer. All test fields were measured, the results were summarized in a table, in a diagram for better interpretation, and the results obtained were evaluated. The test sample was digitalized as well; however, the fine details cannot be seen correctly.

The examined technologies are not only built around the increase in density, but they optimize ink spreading as well; therefore, we briefly examined the mottle value and graininess, too. Examining these two factors together resulted in the conclusion that the ACT D plate produced by Flint Group has the properties most appropriate for printing on brown kraft paper. The test sample also revealed that optimal setting is 180% laser power and MCWSI structure.

Other parts of the test – dotfail test, determining minimum points, appropriate fade setting – need to be further examined; therefore these are not detailed in the evaluation.

It can be concluded that our objective has been achieved, since we have found at least one sample and setting suitable for – based on the results of the test – printing on brown paper.

Based on the contents of the article, it can be concluded that flexo printing plate making is developing dynamically, and it will hopefully continue this route in the future. The key to success is to always pursue achieving the best results with the available materials and devices, and to use them to their maximum. Manufacturers are constantly working on developments. The technology is continuously improving, and new plates appear on the market. It is not clear how long a certain solution remains relevant. The result of our test will only be suitable for use in practice, until one of the parameters of the work process is changed in a way that another process produces better results. However, in our opinion we have selected the best solution – based on the materials and devices available today – and this knowledge will contribute to creating attractive and up-to-date packaging materials.

5. ACKNOWLEDGEMENTS

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We would especially like to thank the staff of Krajcár Csomagolóipari Kft. for assisting us in the test printing process. They offered their time, human resources and raw materials to complete this experiment.

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