Development of Digital Quasi-embossing Technology with an Inkjet Printer

Naoki Matsumae[1], Masaru Ohnishi[2], Hironori Hashizume[2] and Takao Abe[1]
(1)Division of Science and Technology, Shinshu University, Ueda City, Nagano Prefecture, Japan
(2) R & D Division, MIMAKI ENGINEERING CO., LTD. Tomi City, Nagano Prefecture, Japan

Abstract

Emboss technology utilizing hot-stamping method can produce stereo-printed images with metallic gloss. Conventional emboss method needs an engraved plate and consequently becomes costly especially for a small quantity production. We have developed a new technology with combining UV-curable inkjet printing and hot-stamping processes, where any engraved plates are not used. The new technology called "Quasi-embossing Technology" consists of the following three steps: (1) On the basis of three-dimensional image data, stereo-printed images are formed with a UV-curable inkjet printer, where the print-head accompanying a UV irradiation setup scans several times. (2) A metallic foil which has a hot-stamping adhesive layer is placed on the stereo-printed image with supplying heat and pressure from the back of this foil. (3) After having been cooled, the surplus foil around the stereo-printed images made from UV-curable inkjet ink is removed. Finally three-dimensional products with metallic gross are obtained. This technology is applied to produce various products including conventional emboss printing ones.

Introduction

A conventional hot-stamping method [1] with metal foil can produce high-gloss and metallic shining images on various things such as plastic plates. It is also known that inkjet printing method can produce metallic shining images with a special ink prepared for that purpose. However, there is a big difference in gloss of final images between the two methods. Hot-stamping is superior to inkjet printing from the viewpoint of providing high gloss up to the present.

In order to make stereo-printed images, the following printing methods are known: embossing print, Virko or thermographic print, and thick-ink print. Inkjet printing system can be used for the thick-ink print by putting repeatedly droplets of UV curable ink [2] on the same place. However the result of inkjet is worse than a conventional embossing print. Change in color and gloss used to occur at the convex part in the case of inkjet printing.

This paper deals with the "digital quasi-embossing technology" which has been named by us. This technology uses an inkjet printer with UV curable ink which does not contain coloring agent and consists of the following process. Firstly images formed by UV curable ink are made on a certain film, e.g. PET film, and then UV light is irradiated. At the next step, a special film such as a metallic transfer foil is put on the ink images with heat and pressure, and finally the surplus foil around the stereo-printed image is removed. Through these steps, we can produce impressive solid body images with high gloss and various colors. If a hologram layer is put on the UV ink images instead of a metallic transfer foil, unique perception will also be brought.

The digital quasi-embossing technology can be applied to various places by combining with other technology. For example, wood-grain wall materials will be decorated by applying this technology, where the colored and raised wood-grain pattern will be made with metallic shining.

In this paper, we will introduce the basic process of the quasi-embossing technology. Various samples have been made by modifying the process. Some of them will be shown at the presentation.

Experimental

We used the printer and materials described below.
Inkjet printer: UJF-3042, LED-UV manufactured by MIMAKI ENGINEERING CO., LTD.
Metallic transfer foil and color transfer film: MURATA KIMPAKU CO., LTD.

Digital quasi-embossing process and its modified processes

Basic process

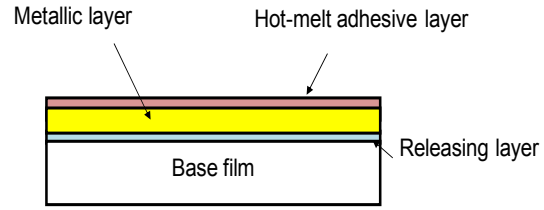
Figure 1 shows the basic process of the digital quasi-embossing process. As seen in Fig. 1(a), the metallic transfer foil has transferable layers on a base film, that is, a hot-melt adhesive layer, a metallic shining layer and a releasing layer. Using this foil, we can form metallic shining stereo-printed images as described below.

(1) As shown in Fig. 1(b), stereo-printed images are made with the UV-curable inkjet printer described above, where the UV-curable ink does not contain any colorant or coloring agent usually. We call this kind of ink "UV clear ink" below in the present paper. However, we can also use UV-curable ink containing coloring agent such as white pigment, so long as the color of the ink does not lead deterioration of final products. Height of stereo-printed images or ink thickness can be controlled by the method that the inkjet printing accompanied by UV light irradiation is carried out repeatedly on the basis of image data. Fig. 2 shows conceptually the case of four-time printing. When printing is carried out repeatedly, each image data is not always the same and each image pattern can be changed little by little. Thus we have been able to make the stereo-printed image with the height of 10μm to hundred μm, depending on the purpose.

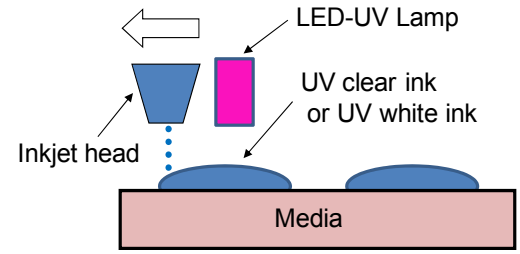
(2) Metallic transfer foil is put on the stereo-printed image for hot-melt adhesive layer to face to the image as shown in Fig. 1(c). At the same time heat and pressure are applied from the rear side of the metallic transfer foil.

(3)Finally base film of the metallic transfer foil is peeled off.

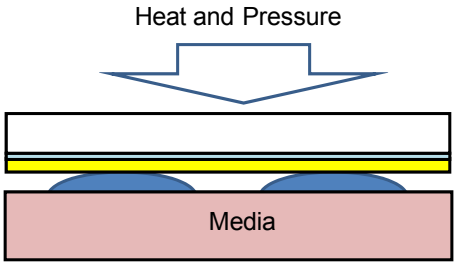
The process of digital quasi-embossing method is finished through the above steps. Fig. 3 shows one of the samples manufactured by way of trial in this study. The whole surface of the sample sends out metallic shining.



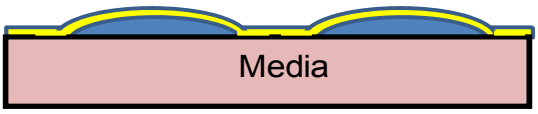
(a) Metallic transfer foil



(b) Step for inkjet printing with UV-curable ink



(c) Step for laminating metallic shining layer



(d) Completion of Quasi-embossing print

***Figure 1**. Digital metallic quasi-embossing process*

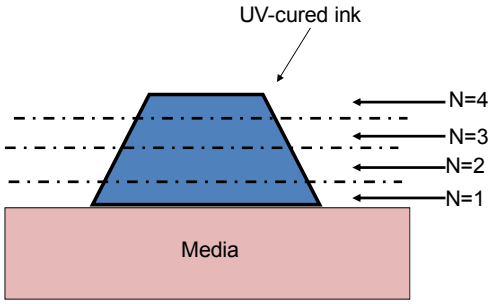


***Figure 2**. Conceptual cross section of cured ink image.*
Height of cured ink is controlled by the times of UV-curable inkjet printing.
A shape of a cross section is determined by the image data of Nth-printing.

***Figure 3**. Print sample by Digital quasi-embossing technology*

Digital quasi-embossing process for partial transfer of metallic layer

This process is the case that the metallic layer is transferred only to the raised portion of UV-ink images. The metallic transfer foil of this case does not have a hot-melt adhesive layer as shown in Fig. 4(a). The procedure is as follows:

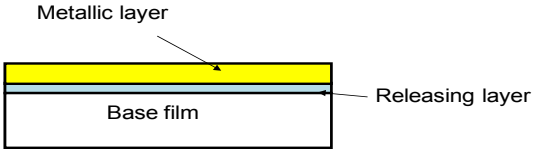
(1) Inkjet printing with UV-curable ink is made in the same way as mentioned above (Fig. 4(b)).

(2) Inkjet printing with UV clear ink is carried out on the image printed at the above step (1). As seen in Fig. 4(c), the UV clear ink is placed only upon the image portion. At this step UV light irradiation is not provided at all, or according to circumstances very weak UV light is irradiated to prevent image blur resulting from ink spread.

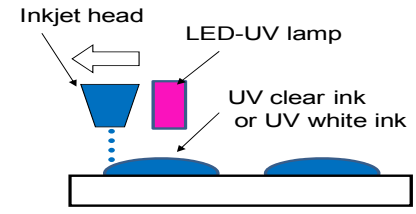
(3) Metallic transfer foil is laminated to the surface of inkjet images with pressure. UV light irradiation is accompanied at the same time (Fig. 4(d)). When the UV clear ink is cured, metallic shining layer comes to adhere tightly only to the image portion.

(4) The metallic transfer foil is peeled off after having been cooled.

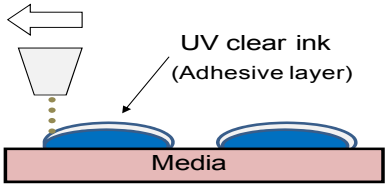
Through these steps we can produce final products. An example of products is shown in Fig. 5. Only the character potion has got metallic shining.



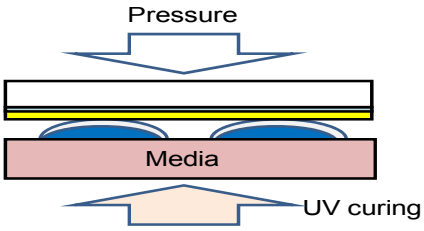
(a) Metallic transfer foil



(b) Step for inkjet printing with UV-curable ink



(c) Step for UV ink placing



(d) Step for laminating metallic shining layer

(e) Completion of partial metallic transfer only onto image portion.

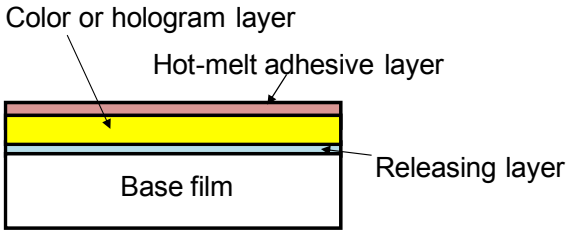
Figure 4. *Digital quasi-embossing process for partial metallic transfer*

Digital quasi-embossing process for color or hologram layer

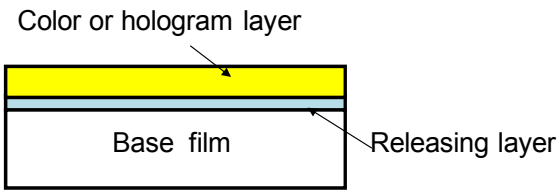
When a color transfer film or a transferrable hologram film is used instead of the metallic transfer film mentioned above, interesting results have also been brought. The procedure of manufacturing is similar to the above. The color film and the transferrable hologram film, those have been used in this study, are shown in Fig.6.

Figure 7 is an example of samples, when using a color transfer film and Fig. 8 when using a transferrable hologram film.

Figure 5. *Print sample by digital quasi-embossing technology for partial transfer of metallic layer*



(a) Color or hologram transfer foil which has hot-melt adhesive layer



(b) Color or hologram transfer foil which does not have hot-melt adhesive layer

Figure 6. *Transfer films for color or hologram layer printing*

Figure 7. *Print sample with color layer*

Figure 8. *Print sample with transferrable hologram layer*

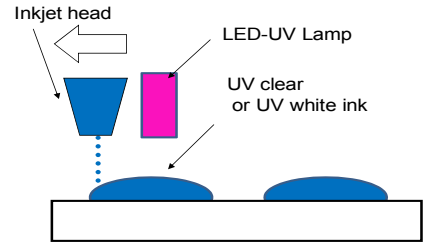
Digital quasi-embossing process for color image print

In order to decorate the specified part of color images, our digital quasi-embossing technology can be applied easily. The procedure is shown in Fig. 9.

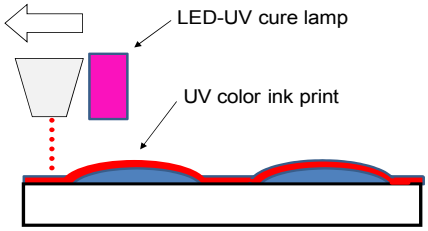
(1) Inkjet printing with UV clear ink or UV white ink is carried out in the same way as described above.

(2) Normal inkjet printing with color UV-curable ink is done on the part of image area where is wanted to be colored.

Figure 10 shows printed samples of the pattern of wood grain of a board. Comparing Fig. 10 (b) and Fig. 10 (c), we can recognize the effect of the digital quasi-embossing technology. The sample of Normal UV-curable printing does not show any effect (Fig. 10 (b)). On the other hand, since the digital quasi-embossing technology produces an uneven surface with the pattern of wood grain, the sample gives us natural impression to some extent just as if we are touching a real wood board. The thickness of UV-cured ink of Fig. 10 (c) is 50μm.



(a) Step for inkjet printing with UV-curable ink



(b) Step for UV-curable inkjet printing to all of media surface

***Figure 9**. Digital quasi-embossing process for color image print*

Summary

We have newly developed the "digital quasi-embossing technology" and tested the following modification of the technology:

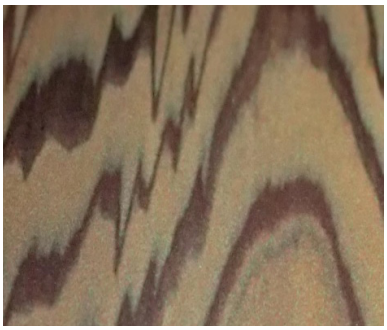
(1) Digital metallic quasi-emboss printing on all image surface,

(2) Digital metallic quasi-emboss printing on a part of image surface, and

(3) Digital color quasi-emboss printing on the specified portion of printed image.

Through a series of experiments, we have confirmed that the digital quasi-embossing technology can take partially a certain place having been occupied by the conventional methods such as thick-ink print. The digital quasi-embossing method is expected to be suitable to manufacture many kinds and small quantity of products.

(a) Entire photo of grain image



(b) Close-up photo of normal UV color print

(c) Close-up photo of quasi-embossing method

***Figure 10.** Print samples digital quasi-embossing process for color image print*

We have made some samples and been able to confirm the strong points of the digital quasi-embossing technology in terms of image perception.

References

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Author Biography

Mr. Naoki Matsumae is a graduat student, Division of Science and Technology, Shinshu University, Japan.