New Gravure Technologies
DIRECT LASER ENGRAVING IN COPPER

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GrC 329 - FALL 2007
Abstract
Gravure is known for its simplicity, quality and reproducibility. However, a drawback to the traditional electromechanically engraved cylinders in Gravure has been the quality of the linework, since both type and images are reproduced using the same resolution. Hell Gravure Systems has been working to improve the quality of linework in Gravure, and has succeeded in producing the first laser engraver that can engrave directly into copper, a new technology that has greatly improved the quality of linework reproduction in Gravure.

Introduction
Electromechanical engraving has become the method of choice for engraving an image into a copper cylinder for use in Gravure printing. With electromechanical engraving, the cylinder is engraved with a diamond stylus. This process is simple, reliable, and relatively lower in cost than some of the other methods of engraving.¹ However, electromechanical engraving does have some drawbacks in terms of contour definition. With this process, images and text are reproduced with the same engraving screen, and therefore the text and is not as clean or sharp as with other printing processes. When looking at text and other line elements printed by an electromechanical engraving process, jagged edges will be seen on the elements. HELL Gravure Systems is working to improve the quality of text and linework reproduction in two different ways. One is further development of the electromechanical engraving method and the other is a development project which would allow direct laser engraving in a copper or chromium surface.¹

Methodology
HELL Gravure Systems GmbH is the world’s market leader for digital Gravure systems. Since Dr.-Ing. Rudolf Hell invented electromechanical engraving, more than 1000 HelioKlischographs have been installed worldwide. HELL Gravure Systems is focused on the development, manufac-

turing, sales and support of system solutions for digital print form production in packaging, decorative and publication Gravure, and now also in flexo packaging. The primary focus is the engraving machine and laser imager itself and on the image processing systems for controlling these. HELL Gravure Systems is located in Kiel, Germany, with subsidiaries and demonstration facilities in Germany, Malaysia and China. In all other countries authorized agents represent the HELL product lines.²

To improve the electromechanical engraving process, HELL Gravure Systems has come out with a new engraving head, called the “Xtreme” electromechanical engraving head. This new engraving head works with different resolutions for text and image, which allows text and linework to be reproduced with a higher resolution, and therefore the appearance of jagged edges will be reduced. Below is an example of linework printed by tradition electromechanical engraving and then by the “Xtreme” electromechanical engraving head. It is clear that the image printed with the “Xtreme” engraving head has significantly cleaner edges and a higher saturation of ink.

The “Xtreme” electromechanical engraving head allows printers to achieve a higher write resolution without compromising ink volume. Because cells are made three-dimensionally in standard electromechanical engraving, ink volume diminishes with higher resolutions. The Xtreme Engraving method allows for a variety of cell shapes to be made, thereby improving ink saturation

while increasing contour definition of characters.³

Based on the engraving principle of the electromechanical “Xtreme” engraving head, HELL has developed a prototype of a laser engraver which creates the cells directly in a copper or chromium surface, a method that was thought to be impossible for the past forty years since the copper surface is so reflective of the laser light. As with “Xtreme” engraving, the write resolution of the laser beam in this method is also independent of the adjustable resolution of the Gravure screen.¹ With this new method of laser engraving directly into copper, the laser beam is so fine and the power of the laser light is so high that the focussed beam achieves an incredibly high power density on the cylinder surface. The copper, which is usually a good mirror for laser light, melts and is expelled from the cells.¹ Prior to this new technology, the cylinders had to be completely covered in epoxy resin, with laser engraved cells in the resin. However, this resin compound could not withstand a print run of five million copies because particles were getting trapped in the ink pans. These particles became trapped between the cylinder and the doctor blade, which lead to scratching on the cylinder.⁴

Laser engraving is rapidly becoming a high-quality alternative for cylinder preparation because it offers excellent sharpness and detailed reproduction of images and text. Compared to electromechanical systems, laser provides for higher and more uniform quality and shorter makeready, with a minimum of color shift and moire. Today’s equipment can engrave up to 70,000 cells/sec with variable screens, such as conventional and FM, assuring drift-free color. Laser-engraved cells are actually spherical in shape, providing improved ink release. For example, to achieve a comparable printing density, the depth of a laser cell is only approximately 2/3 of an electromechanically engraved cell. Consequently, finer screens are possible, while still obtaining the


⁵ Lombardi, Dawn M. “Gravure technology forges new capabilities.” Converting Magazine, Sept. 1999 v17 i9 72(3)
required print density.\textsuperscript{5} Below is an example of type using electromechanical engraving into copper, and then type using direct laser engraving into a chromium surface.\textsuperscript{1}

![Electromechanical Stylus Engraving](image1.png) ![Direct laser engraving in a chromium surface](image2.png)

According to an article by Xiaoying Rong about the performance of laser-engraved cylinders compared with electromechanically engraved cylinders on different substrates, it was reported that laser-engraved cylinders have better performance when printed on different substrates in terms of higher density, lower mottle, higher gloss, and smoother tone curves. The smoother dot-gain curves of laser-engraved cylinders can be a benefit of achieving better gamma correction curves. Laser-engraved cylinders are less affected by ESA (Electrostatic Assist). When ESA is off, laser-engraved cylinders can achieve lower mottle and dot-gain differences compared with ESA on. The cell shapes on laser-engraved cylinders played an important role in increasing densities and dynamic ranges, which are important aspects of achieving a better appearance in Gravure printing.\textsuperscript{6}

**Results**

Since laser-engraved cylinders have an overall better performance than electromechanically engraved cylinders, HELL Gravure Systems has worked to continue improving this process, and

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\textsuperscript{6} Rong, Xiaoying. “Gravure Printability Comparison of Laser and Electromechanically Engraved Cylinders.” Western Michigan University, April 2004 GEF. Sun Chemical Technical Essay Contest.
the end of June 2006, HELL Gravure Systems succeeded in making a long sought after break-through. At 4Packaging in the German town of Dissen, HELL introduced Cellaxy, the new laser engraver which engraves directly into copper. All the world’s top names in Gravure cylinder manufacturing were there to get their first look at the direct laser engraving of copper Gravure cylinders in one of the most cutting-edge and productive fully automatic cylinder manufacturing operations anywhere in the world.  

With direct laser engraving of copper Gravure cylinders, HELL is reinventing engraving. The centerpiece of the process is the newly developed laser which, for the first time, provides the power density required to process a copper surface. The various possibilities for controlling the laser enable the creating of Gravure cells whose depth profiles can, to a large extent, be freely selected. This makes it possible to fully exploit the contone properties of Gravure printing.

Cellaxy, HELL’s new laser engraver will play a key role in the future of Gravure printing, in par-

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ticular for high quality packaging. At present, the speed of the Cellaxy is only adequate for packaging Gravure cylinder engraving. This new technology allows 100% linework engraving, and the new direct laser engraver will be used to print high quality packaging such as cigarette packets, labels, pharmaceuticals, etc.

Since the conventional printing market is shifting to shorter runs, Gravure's response with laser engraved cylinders like the Cellaxy is helping Gravure to compete with Flexo in the packaging sector. The quality and reproducibility of Gravure printing is making Gravure a leading competitor for packaging jobs. Brands are paranoid about getting printers in different countries to reproduce their logo, candy package, etc. with exactly the same in color and registration. The consistency of Gravure makes it a sought after process for the packaging of these brands.

After HELL deploys the new laser engraving tool for direct engraving of the copper Gravure form in the packaging sector, it will then, after an appropriate pilot phase, introduce it to the catalog and magazine sector for large Gravure forms.

**Concluding Remarks**

Direct engraving of copper Gravure forms was developed on the basis of the familiar electromechanical engraving process and a new laser engraving tool. Both methods – Xtreme and direct laser engraving significantly enhance contour definition and hence text and line reproduction. This is achieved by breaking the link between processing definition and screen definition. Both methods also enable fine control of engraving depth, which for the most part is also independent of the cell area.

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It seems that Hell Gravure Systems has solved the problems that Gravure has had with the quality of linework reproduction, and has put Gravure on the competitive edge with flexography for packaging with the introduction of the Cellaxy.

References


Lombardi, Dawn M. “Gravure technology forges new capabilities.” Converting Magazine, Sept. 1999 v17 i9 72(3)


Rong, Xiaoying. “Gravure Printablity Comparison of Laser and Electromechanically Engraved Cylinders.” Western Michagin University, April 2004 GEF. Sun Chemical Technical Essay Contest.


**Outline**

**ABSTRACT**
- Gravure
  - Simple and repeatable process, high quality
  - Drawback to the traditional electromechanically engraved cylinders
    - Same resolution for images and linework
  - HELL Gravure Systems working to improve linework reproduction
    - HELL produced first laser engraver that can engrave directly in copper

**INTRODUCTION**
- Electromechanical engraving
  - Most popular method of engraving cylinders for Gravure
  - Drawback to electromechanical engraving
    - Jagged edges on linework because printed at the same resolution as images
- How HELL Gravure Systems plans to improve linework reproduction
  - Further development of electromechanical engraving
  - Direct laser engraving in copper and chromium

**METHODOLOGY**
- Who is HELL Gravure Systems and what do they do?
  - The world’s market leader for digital Gravure systems
  - Dr.-Ing. Rudolf Hell invented electromechanical engraving
- Electromechanical Xtreme engraving by HELL Gravure Systems
  - Engraving head works with different resolutions for text and images
    - Image of linework improved by Xtreme engraving head
- New laser engraver by HELL that engraves directly in copper
  - New laser engraver developed based on Xtreme engraving head
- Hell Gravure Systems developed a prototype of a laser engraver which creates the cells directly in a copper or a chromium surface.
- For over forty years, it has been thought that laser engraving a copper cylinder was impossible.
  - Copper is too reflective of the laser light.
- HELL was able to produce a laser that has such a high density and can melt the copper and expel it from the cells.

• Laser engraving prior to this new technology.
- The cylinders had to be completely covered in epoxy resin, with laser engraved cells in the resin. However, this resin compound could not withstand a print run of five million copies.

• What are the differences between electromechanical engraving and laser engraving?
- Quality of laser engraving compared to electromechanical.
  - Laser provides for higher and more uniform quality and shorter makeready.
  - Laser engraves cells are spherical and improve ink release.
  - Image of type printed by electromechanically engraved cylinder in comparison to type printed by a direct laser engraved cylinder.

• Electromechanical vs. Direct engraving print quality on different substrates.
- Laser engraved cylinders have higher density, lower mottle, higher gloss, and smoother tone curves on different substrates.
- Laser engraved cylinders are less affected by ESA.

Results

• Introduce Cellaxy.
- HELL Gravure Systems has succeeded in making a long sought after break-through.
- June 2006, HELL introduced Cellaxy, the new laser engraver that engraves directly into copper at 4Packaing in the German town of Dissen.
* Image of all the world's top names in Gravure cylinder manufacturing looking at the 

**Cellaxy**

- The **Cellaxy** will play a key role in the future of Gravure printing, in particular for high-quality packaging
  
  * Cigarette packets, labels, pharmaceuticals, etc.

- Is Gravure in competition with Flexo?
  
  * Direct laser engraving quality for packaging compared to flexo
    
    * Consistency of Gravure, good for brand packaging (same colors)

- Future of **Cellaxy**
  
  * After packaging sector, catalog and magazine sector for large gravure forms

**Concluding Remarks**

- Direct engraving in copper and Xtreme engraving
  
  - Both improve quality of linework

- The **Cellaxy** was a huge break-through for HELL Gravure Systems
  
  - Gravure now on competitive edge with flexography