Gravure Printing: Developments to Increase Competitiveness

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Abstract

Even if publication gravure printing will play an increasingly minor role in the future because run lengths are continuing to fall, it has unique selling points, such as format variability, which will allow it to survive in a niche market in the long term.

Packaging gravure printing is in competition with flexographic printing and, increasingly, digital printing. In order to become more competitive, it must reduce color waste and set-up times in particular. This can be achieved by adopting and applying the development towards extended color gamut. The very stable gravure printing process is generally well suited to this. To enable ECG, the color register of the gravure press must be optimized in all aspects. Furthermore, the inking unit must be stabilized, e.g. with thermostatisation.

In form cylinder production, the chromium(VI) process, including the use of PFAS for the chromium protective layer, must be replaced in the medium term. This can be done using a chromium(III) process that has now been developed. Furthermore, if the expensive and time-consuming production of form cylinders, including cylinder transport, which requires long lead times, is to be improved in general, electroplating must be dispensed with completely and polymer cylinder surfaces used instead. Several serious developments are currently taking place in this area. The most promising are HelioPearl from K. Walter and EcoGrav from Rossini. With cylinder surfaces of this type, even smaller gravure printing companies could bring their cylinder production back in-house, thereby significantly reducing the cycle time and costs of cylinder production. This technology also requires significantly less material and energy.

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In combination, gravure printing could become more attractive again and maintain its market position in the long term.

Commercial gravure printing

In the competition between publication rotogravure and web offset, web offset is the clear winner. The market has seen a significant decline in the volume of printed products produced since 2008, in some cases by more than 10% per year.

In the US, gravure has traditionally played a minor role in the publication business. In Europe, however, several commercial gravure printers are disappearing every year. Since there is no longer a press manufacturer for publication gravure presses, the presses are only getting older and less competitive.

In addition, long runs are generally on the decline. Initially, they were uneconomical for gravure printing and were therefore taken over by web offset. Today, some of these jobs are disappearing altogether or are being reduced by orders of magnitude because of the extremely high cost of distribution to households. Web offset is now facing a problem similar to that of publication gravure printing a few years ago, and the number of web offset printers is also dwindling.

Compared to web offset, gravure has some permanent advantages. One is the variability of cut lengths. Products can be produced beyond the standard formats. This sets these products apart from the vast majority and creates a unique position. Special finishing options, such as producing a product with content pages and a cover in one run by gluing multiple ribbons together to create the cover, can create unique selling points (Rose 2023).

As print becomes less of a commodity and more of a premium medium in the future, these unique selling points will create a specialty and niche market that will continue to exist.

Packaging gravure printing

Packaging gravure is in competition to flexography and increasingly so to digital printing.

The main advantages of the gravure are:

- Easiest variability of the cutting length within a tenths of a millimeter, so that the substrate can be used to the maximum,
- Very stable and consistent print and print quality, so the customer know exactly what they are getting,
- Job repeats with the already existing print form, so no additional form costs,

- Highest variability of printable pigments, important e.g. for metallic or irodine pigments
- Highest transferable ink volume, important e.g. for white layer in reverse printing, coating of lacquers or cold seal glue

Gravure Press

The challenges for gravure printing are at the press level, particularly around ink changes in the printing units. In printing, changeover time from one job to another and the resulting waste is a particular competitive constraint. In packaging gravure, color changes often have to be made on several printing units because of the different colors between print jobs. Even with trolleys and quick-change equipment, this is an expensive and time-consuming process.

Normal packaging jobs often have more than 4 colors, sometimes up to 9 or more. The inks used are therefore mainly spot colors and need to be changed for the next run. Getting the ink to the right color requires at least 2, and often many, press starts and stops. This results in high waste and long changeover times. After the run, a significant amount of ink is left over, several kilograms per printing unit. Disposal is costly. Reuse would be beneficial. However, this requires thorough organization and reduces the quality of the pre-mixed inks for the next job (Krystosiak K., 2024). To improve packaging printing, one can look at the commercial printing process, which has an extremely high degree of automation. It uses a fixed set of inks and a fixed assignment of printing units to the ink. This reduces job changeovers to change the plate cylinder. Ink waste and disposal costs are dramatically reduced. The analogous approach in packaging is the use of Extended Color Gamut, since the brand colors and many parts of the packaging require colors outside the normal CMYK color space.

Looking at the implementation of ECG in gravure, there are a number of constraints. First, up to 7 colors/print units are required to cover the extended color space. This is generally not a major problem as most gravure presses have sufficient units.

Next, very stable printing conditions and predictable print forms are required, as only a high degree of standardization can guarantee a predictable and reproducible result in ECG printing. Gravure printing is already more stable than other printing processes, but to ensure stability, the viscosity and temperature of the ink must be kept constant to a high degree. This includes sensitive viscosity and temperature control of the ink circulation. On the cylinder side, high quality engraving is required with small volume tolerances for the cells. All of these conditions can be met if the printing and cylinder manufacturing processes are carefully managed.

Good color register over the entire print area is also required. When printing process colors, the color register deviation must be smaller than when printing spot colors to keep color shifts within limits. This is particularly challenging because gravure printing is a wet-on-dry process, which means that a dryer and a long web path between the printing nips are unavoidable. For longitudinal and lateral register, a fast and finely responsive register control is required. For diagonal register, inline measurement and motorized control must be implemented. For fan-out, inline measurement and sensitive control are required.

Color separation for ECG is also special and not common knowledge. Corresponding software that can use any colors as process colors and a clear definition of standard printing conditions is necessary. The G7 consortium already defined ECG conditions (Hutcheson D., 2024), which in principle could also be used for gravure. As with any complex printing condition, great care is required when creating the fingerprint. Last but not least, the implementation requires the acceptance of the customers, as the change to ECG may slightly change the appearance of the product. Communication with the customer and proof of quality are prerequisites for success.

Print form – replacement of the chromium(VI) process

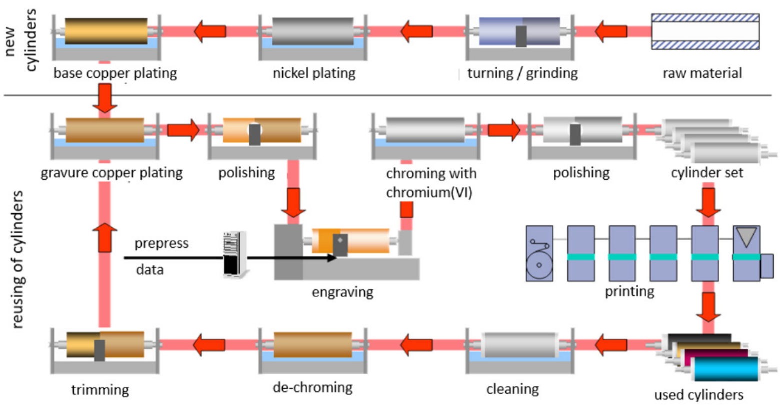
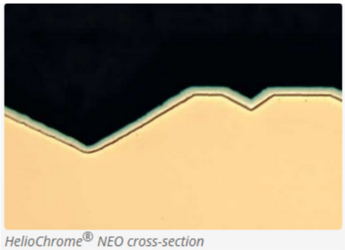


Figure 1: *Gravure cylinder manufacturing steps*

As shown in Figure 1, there are many steps involved in making gravure form cylinders. The figure even omits a couple of cleaning and preparation steps between the functional steps. Electroplating is complex, and for gravure printers who buy in cylinder production from cylinder making service companies, the heavy cylinders must be transported, adding significant transportation time and cost.

A particular problem at present is the toxic production of the chromium wear-resistant layer of the form cylinder. The chromium(VI) ions required in the actual plating process are toxic. So this electroplating process is about to be banned by the EU. Even worse, this process requires additives containing PFAS, which are also on the banned list.

The use of chromium(VI) will be allowed in the EU with restrictions until 2032. (K. Walter, 2024)

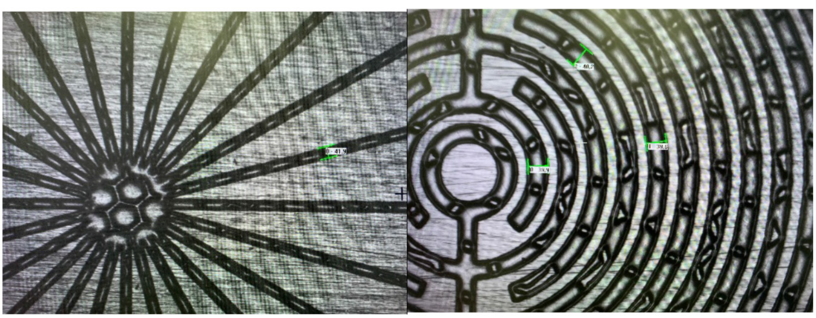


Picture 1: *Cross section of the HelioChrome Layer (Gschoßmann C., 2022)*

Fortunately, there are now alternatives. HelioChrom NEO is an electroplating process developed by K. Walter, that uses only Chromium(III) ions, which are much less toxic. The development is now completed and its market launch is underway. The process is able to replace the old chromium(VI) process in the gravure cylinder form making and needs lower temperatures and less energy. However, it requires a new electroplating bath with additional features and control options.

For special applications RotoHybrid developed a wear resistant coating made of diamond like structured carbon, which is deposited in vacuum.

This DLC layer is chemically inert, very durable and has a very good ink release especially for fine structures.



Picture 2: *Microscopic pictures of DLC coated cell structures in a gravure cylinder (own picture)*

The disadvantage of this process is, that it is more expensive and takes longer than chroming. This is prohibitive for day to day print jobs in packaging. On the other hand, in the area of speciality and security printing it might find its application, as these are less cost sensitive and especially need the high quality printing of fine or ultra-fine structures.

Polymeric print forms

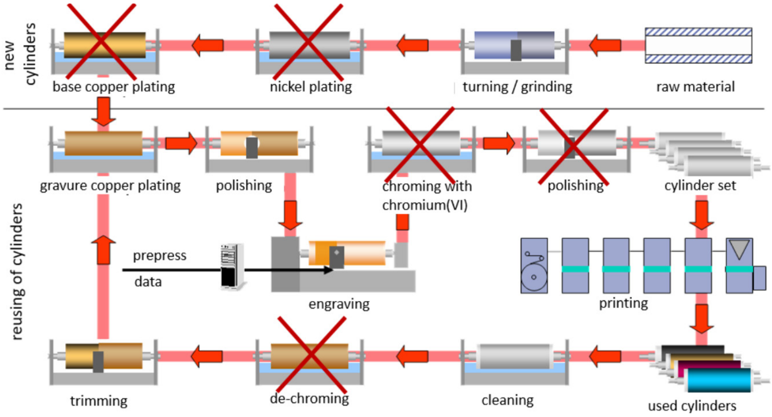


***Figure 2:** Process steps for polymeric print form*

Polymeric printing forms, i.e. a printable surface of the gravure cylinder with the right roughness and engraved cells made of polymers instead of metal, have been under development since the 1980s, when Crosfield started such a project.

Unfortunately, the project never made it to market. This was partly due to the fact that chromium was uncontroversial at the time, and partly because the polymer surfaces were not stable enough for the long run lengths of the print jobs. In the years that followed, at least basic research was conducted to determine whether suitable polymers were now available. Compared to 40 years ago, both material knowledge and laser technology, both continuous wave and short pulse, have advanced considerably.

In addition, print run lengths have been steadily decreasing, and in the packaging sector in particular, the average print run is now well below 20,000 meters.

Together with the problematic process of chrome plating, this opens up an interesting development window for new polymer surfaces.

Three such developments are currently known.

- HelioPearl from K. Walter
- EcoGrav from Rossini
- DynaSurf from Continental

There are rumours that even more may come.

K. Walter: HelioPearl

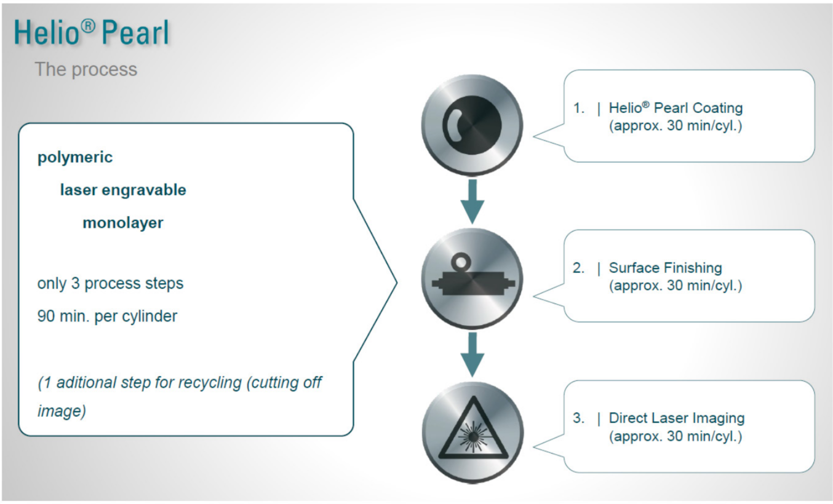


Figure 3: *Process steps for HelioPearl print form (K. Walter, 2022)*

Picture 3: *HelioPearl print form (K. Walter, 2022)*

HelioPearl is more than 10 years in development. It uses a nanoparticle reinforced polymer that is applied to the cylinder as a monolayer like a lacquer with a thickness of 1/10 mm to 3/10 mm. After curing with UV light, the surface is ground to shape and roughness with a conventional gravure cylinder surface finishing device.

Short pulse laser engraving is required to engrave the cells into the surface. The polymer cannot be engraved electromechanically. However, the engraving requires much less laser energy than engraving the cells in copper or other metal. In addition, no debris is deposited during the laser process. The resulting surface is highly wear resistant and can withstand at least 100,000 revolutions even with long-lasting doctor blades.

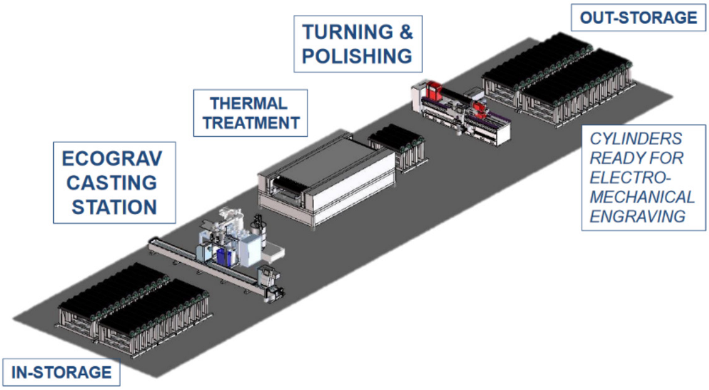
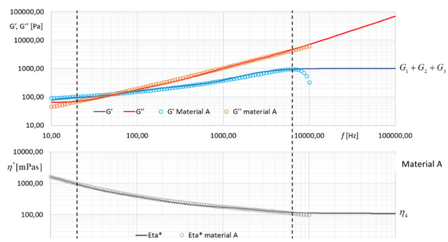


Figure 4: *Process steps for EcoGrav print form (Losa F., 2022)*

Since Rossini comes from rubber coating, EcoGrav uses a type of very hard rubber based thick monolayer. The cylinder is coated with a very specific rubber recipe with a thickness of several millimeters.



Picture 4: *Rubber coating of an EcoGrav print form (own picture)*

When applied, the rubber is very brittle. A subsequent heat treatment reduces its brittleness to allow electromechanical engraving and to provide the necessary wear resistance for printing. As with all cylinder manufacturing processes, the next step is surface finishing, where the surface is turned to shape and ground to roughness using a conventional gravure cylinder surface grinder.
The cells can be engraved via electro-mechanical engraving, but laser engraving seems to be possible too, again with much less energy than for metal.
Rossini claims a wear resistance of more than 100.000 revolutions.

Savings and challenges with polymeric surfaces

A clear picture emerges when comparing the resource consumption of conventional electroplating and polymeric printing forms.

Electroplating requires energy to deposit the metal and to heat the bath. Using HelioPearl as an example, this process can save approximately 96% of the energy required for electroplating. The thin and relatively light polymer layer also saves about 87% of the material used (DBU, 2021). In particular, there is no need for a wear protection layer.

However, there are also disadvantages compared to the standard printing form. First, the print run is limited. This is currently around 100,000 meters. This can possibly be increased. However, the run length will never reach that of the chrome layer. A polymer, even if it is specially designed for this purpose, can never achieve the durability of a metal.

In addition, the surface is more delicate than its hard chrome counterpart. This means that it must be handled with care. This is analogous to offset development, where process-less plates also require much more careful handling than baked chemically developed plates.

For polymer cylinders, this means a clean working environment and clean or well-cleaned inking units. Avoiding of scratches is critical, as polymeric surfaces are in principle softer than chromed ones.

Game changer Polymeric Print Form?

With these new polymeric printing forms, there is no need for electroplating, at least if you do not need to match the circumference of the cylinder. This eliminates the complicated operation of many electroplating baths. The number of process steps is greatly reduced and the cylinder is ready for printing immediately after engraving.

This would allow even smaller gravure printers to produce cylinders in-house, which would mean a much shorter response time and lower costs.

This would be a development similar to what plate setters did in offset in the 1990s.

Conclusion

The combination of innovative print forms with innovative production methods leads to a significant increase in competitiveness in terms of costs and response times.

Nevertheless, digital printing will continue to gain market share in packaging.

However, the example of online offset printers shows that the forecasts of digital printing analysts have been orders of magnitude too optimistic.

Gravure printing can also achieve this and form a stable economic basis for the coming years.

References

DBU, 2021: Projekt 37380/01: Neuartige Funktionsbeschichtungen für die umweltfreundliche, energieeffiziente Tiefdruckformherstellung.
Available from: https://www.dbu.de/projektdatenbank/37380-01/

Hutcheson D., 2024: G7+™, the World's Best Calibration System, Made Better. *Technical Event Series 2024*

Krystosiak K., 2024: Sustainability Benefits of Expanded Gamut Printing. TAGA Proceedings 2024

K. Walter, 2024: ChromeXtend – authorization receives approval. [Viewed 2024-05-14]. Available from: https://www.kwalter.de/news-update/?lang=en #1658217468538-6191bd22-2270

Gschoßmann C., 2022: Chrome(VI) problem solved! European Rotogravure Association, International Gravure Days 2022. Available from: https://era-eu.org/wp-content/uploads/Gschossmann.pdf

Losa F., 2022: EcoGrav System. European Rotogravure Association, International Gravure Days 2022. Available from: https://era-eu.org/wp-content/uploads/Losa.pdf

Rose, 2023: R-Cover. [Viewed 2024-05-14]. Available from:
https://rose-druck.de/de/leistungen