The Lamination of Thermal Inkjet Media: Effects and Compatibilities

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Abstract

The finishing of a thermal inkjet media may include the lamination of the printed image. This can be done with cold/pressure sensitive, heat-assist or hot/thermal over-laminates or even with liquid laminates. There are many reasons which justify this additional process and they can be divided in three main groups: effects on the physical and mechanical properties (stiffness, curling, tear strength, etc.), effects on the optical properties (color gamut, gloss level, brightness, etc.) and effects on the durability (image permanence, handleability, etc.). These effects may be very different when laminating swellable or micro-porous inkjet receiving coatings, as well as dye or pigmented inks.

The compatibility between the over-laminate, the ink and the media is an essential property to consider when designing any of these components. A good indicator of this compatibility is the peel-strength measurement. Factors affecting this property are the media (coated paper, photo paper, etc.), the inks (type of inks, color and ink coverage), the ink receiver layer, the over-laminate (PVC, polyester, pressure sensitive, heat-assisted, etc.) and the time between laminating and peeling.

Introduction

The thermal inkjet printing technology can be used on a wide variety of media, including plain, coated and photographic papers and films. Their coatings can be of a swellable or porous nature and they are designed to absorb water-based inks. These consist of a vehicle (made of water, surfactants, biocides, etc.) and colorants, which can be dyes (dissolved in water and they penetrate the inkjet coatings, due to their size) or pigments (much bigger than dyes, they are in suspension in water and they don't usually penetrate the micro-porous coating surface).

Most large format inkjet images printed by Print Service Providers are finished. This process may include cutting; laminating; mounting; framing; hemming; etc. Lamination is one of these additional finishing methods which protects a printed image and transforms it into a functional and durable graphic display. This process is usually done in a roller laminator and the laminates can be liquid or films. The film laminates can be pressure sensitive/cold (no heat is needed for their application and they always come with a release liner), heat-activated (little heat is needed and they also come with a liner) or thermal/hot (heat is required and they don't have a liner).

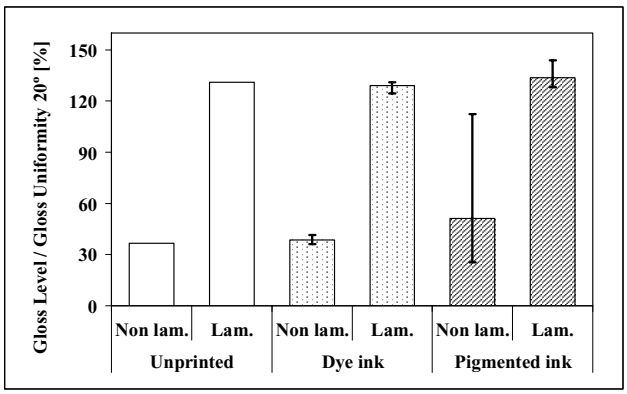
The Effects of Lamination on Inkjet Media

Effects on Physical and Mechanical Properties

All physical and mechanical properties of a media are affected when it is attached to an over-laminate. Grammage and thickness increase (although there is not a direct correlation with the over-laminate grammage or thickness). A polyester laminate (most used for hot lamination) may increase stiffness 3 times more than a PVC laminate (most used with cold lamination), for a given thickness. Tear strength, smoothness, tensile strength and tear length are also improved. The encapsulation (two-side lamination) clearly improves curl and even the one-side lamination may improve curl, especially on those large format media with a roll-set curl. The dry-cockle of a printed coated paper may be also improved, especially with hot lamination or encapsulation.

Effects on Optical & Image Quality Properties

The lamination of porous photo papers usually decreases color gamut: the more matte the finish, the bigger the impact. A matt laminate may reduce color gamut as much as 50%. The effect on coated papers is not so noticeable, as their gamut is already smaller. The gloss level and gloss uniformity of a printed image may be greatly improved, as seen in the attached graph, especially with pigmented inks. Lamination may also be very effective for reduction of printing artifacts, such as pinch-wheel traces; handleability issues, such as finger prints; and other image quality defects, like bronzing.



Effects on Durability

Image Permanence is greatly affected by air, light, water and handleability. The lamination of porous media (coated and photo papers) printed with dye inks, considerably improves the image permanence, as it seals all the pores of the coating, avoiding the air to access the small dye molecules. The surface sealing is also very efficient for water protection, especially on the encapsulated images. Any potential issue with ink abrasion resistance, ink adhesion, finger prints or dusting is solved with the lamination.

Compatibility between Inkjet Media, Inks and Over-laminates

A strong adhesion between the over-laminate and the printed media is required for good compatibility. This is measured with the peel Strength (**pS**) test, which consists of measuring the force of de-lamination between both substrates.

The Influence of the Media Type

Coated papers usually have low internal bond. This limits their ability to give high pS values. The pS of a coated paper may be less than 80% of a porous photo paper, when printing with dyes inks and using hot lamination. In fact, there are many coated papers in the market which give very poor pS performance when using hot laminates. On the other hand, most porous photo papers give excellent pS results when printed with dye inks and using hot over-laminates. The pS of a swellable photo paper laminated with hot overlaminates is usually in the unacceptable range.

The Influence of Inks

Dye inks nicely penetrate into any photo inkjet coating, while pigmented inks do not. The consequence is a very different laminating response. The pS of a hot over-laminate is more than 100% higher when laminating a dye-printed porous photo paper rather than a pigmented-printed one. This difference is not so significant when laminating a coated paper, since the coating pores are much bigger and the adhesive has good penetration into the paper with both inks.

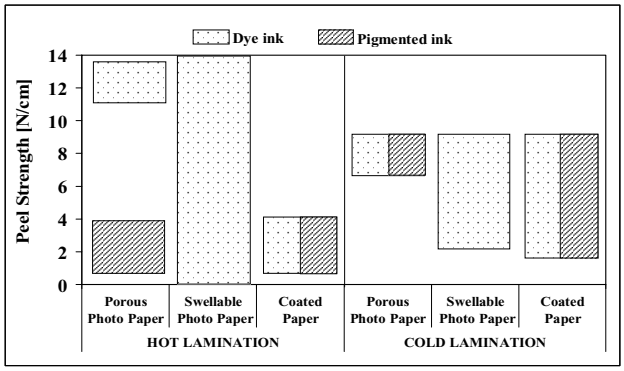
Each color ink has a specific formulation and this also influences the pS. The percentage of pigmented ink in an area fill may also have an impact: 60% area fills may have lower pS than 100% ones.

The Influence of the Over-Laminates and Adhesives

Cold laminates are more forgiving than hot ones. The cold lamination of a porous photo paper printed with pigmented inks may give 75% higher pS than with hot lamination. The cold adhesive have a better penetration into the media coating and it will go through the ink layer. However, the highest pS values have been always observed with the lamination of a porous photo paper printed with dye inks and laminated with hot laminates.

Other Influencing Factors

Other lamination factors impacting pS are the speed of the lamination, the temperature and the ambient conditions. Although the time between printing and lamination does not have a significant impact on pS, it may impact image quality and color shift: as the trapped ink may be flowing under the over-laminate while affecting the color with time. However, the time between lamination and pS testing may have a big influence on the pS results, especially when laminating swellable media using hot over-laminates. This pS may be developing with time (days) in some colors, achieving values never seen with any other media/ink/over-laminate combination. A range of pS values is represented in the attached graph:



Conclusions

The lamination of inkjet media delivers big benefits, from durability to surface finish flexibility. The adhesion of the laminate to the printed media is influenced by the laminate, the ink and the media itself. Given a specific media/ink/over-laminate combination, this adhesion may still be heavily influenced by the ink color, the percentage of ink, the time between laminating and testing, etc. Therefore, it is important to understand and analyze how all these factors affect the adhesion before any assessment about lamination compatibility of a printed media is given.

Biographies

Roman Barba i Mundó received his M.S. degree in Paper & Printing Industrial Engineering from the *Escola Tècnica Superior d'Enginyers Industrials de Terrassa* (ETSEIT - UPC) in 1992. He joined Hewlett-Packard in 1994. His work has been focused on the development of Large Format Media for the HP DesignJet inkjet printers.

David Bujan Isart received his degree in Mechanics Engineering from *Escola Universitària d'Enginyeria Tècnica Industrial de Barcelona* (UPC) in February 2002 and his M.S. degree in Paper & Printing Industrial Engineering from ETSEIT-UPC in February 2005. He joined Hewlett-Packard in 2003 where he worked on lamination of Large Format Inkjet Media.