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LEP PRINTED HIGH PERFORMANCE FLEXIBLE PACKAGING FOR LAMINATION USING ADHESIVE MIXED WITH CROSS LINKER

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LEP Printed High Performance Flexible Packaging Lamination using Adhesive mixed with Cross Linker

Abstract:

High end lamination is a consecutive growing segment in flexible packaging (FP) market. These high value packages are very much desirable by our customers - the flexible packaging converters, and the brand owners which want to stand out with their digitally printed colorful flexible packaging instead of the labeled metalized cans. This growth increases using the ser. 4 printing digital press machine.

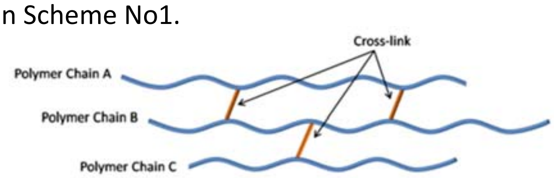
High performance FP applications requires to resist various challenges such as high heat sealing, water and chemical resistance as well as challenge to create retortable products with Liquid Electro Printing (LEP) technology. Retortable products are required to resist high temperature, relative humidity and pressure during the retort process.

The solution available today to offer the digital print customers requires adding an additional step in the FP manufacturing process. A post printing and prior to lamination step, an off line procedure has to be performed i.e. coating the printed film with a cross linker agent. Polymer cross linking forms chemical covalent bonds between polymer chains and primer which leads to improvement in chemical and physical properties of the polymer matrix. By cross linking our primer and ink the flexible package performance is significantly increased so high performance and even for the high demanding processes of pasteurization and retort can be successfully performed. This solution requires also an over-night curing of the cross linker applied in needed and only then the film can proceed the FP manufacturing steps of lamination.

In current publication we present a single step process (one-step). Introducing the cross linker agent at the lamination step procedure of FP manufacturing eliminating the need to add a coating a step to the manufacturing. By mixing the cross linker with the lamination adhesive it is possible to achieve the LEP ink enhancement and enable the digital printed FP to resist the chemical and physical challenges described above. We show that it is possible to achieve the high performance FP applications by cross linking the primer and polymer resin and lamination process in one step, the anyway needed lamination process step in FP manufacturing.

Description:

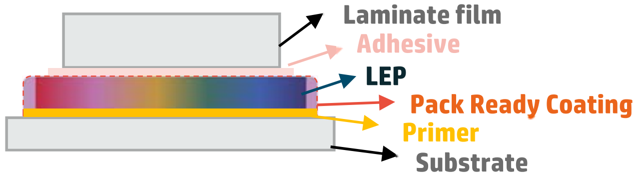
Pack Ready Coating (PRC) is a high performance coating solution that is developed in the labels and packaging R&D group adding an additional step in FP manufacturing. The crosslinking coating which is applied on the digital printed film, penetrates into the ElectroInk (EI) layer and crosslinks resin polymer chains of the ink layers and primer as illustrated in Scheme No1.



Scheme No. 1: CL and EI layer - crosslinking polymer resin of the ink layers

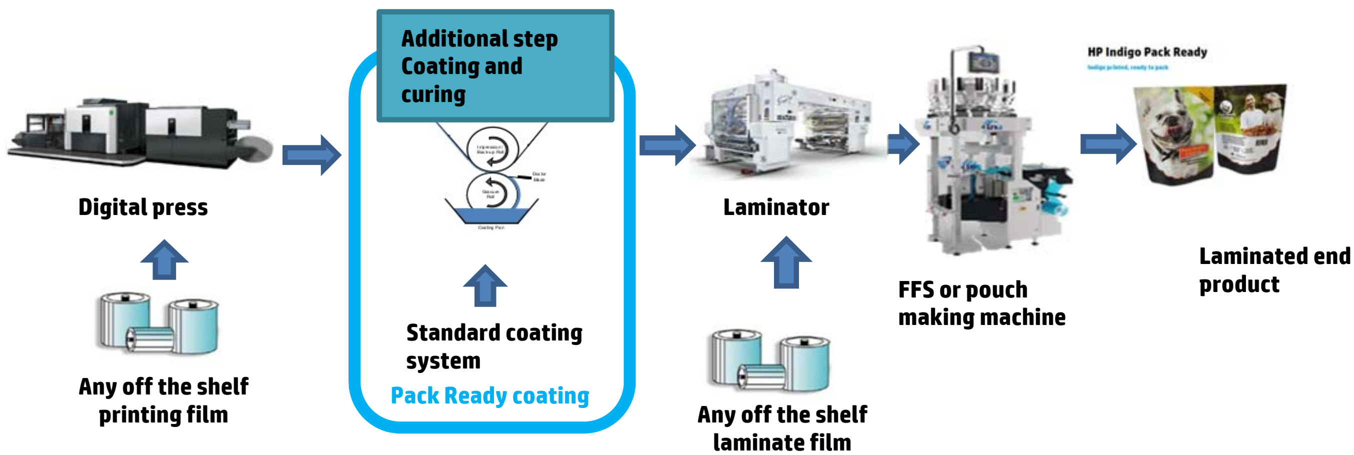
The PRC addition improved dramatically the LEP printed FP resistance and enables it to cope with the various challenges needed as high heat sealing, water and chemical resistance as well as challenge to create retortable and microwable products.

Currently, post printing and prior to lamination, the reverse printed substrate is coated off line with the PRC solution, cured overnight at 50°C . Laminated with a second substrate with an over the shelf high performance adhesive. The structure created is illustrated in scheme No. 2.



Scheme No. 2: Flexible packages structure (not to scale)

PRC and adhesive application is done on the same laminator using a Gravuer printing method with an anilox roll of different BCM size. The PRC process flow is presented in scheme No 3. The PRC solution added an additional step to the FP manufacturing as described in this scheme.



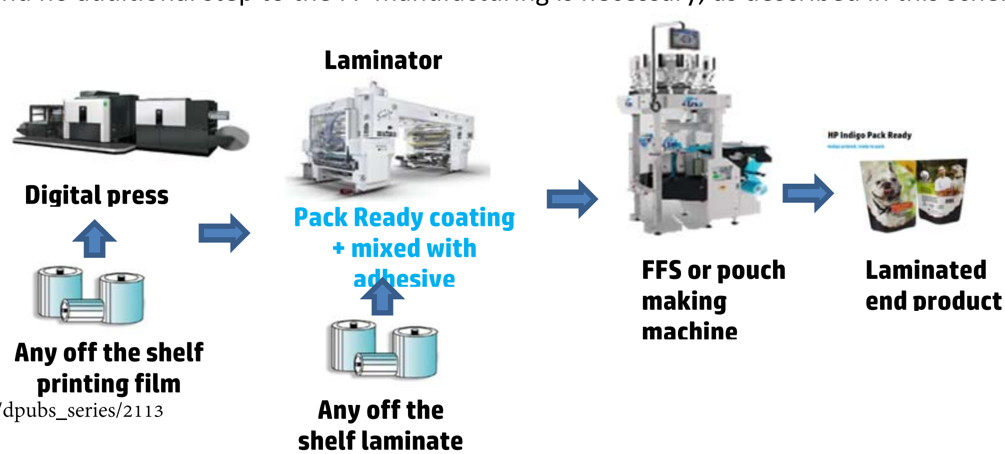
Scheme No. 3: The PRC two step process flow

This publication presents process and test results of laminated high performance films using mixture of the cross linker for coating and adhesive for lamination in one procedure thus, merging the additional PRC step into the lamination steps. The PRC solution is essential to enable high performance retortable LEP printed flexible packages and lamination is a commonly used process in FP manufacturing.

Applying the cross linker in the lamination process means merging the two separate steps into one process step, thus no additional off line step in FP preparation is needed in comparison to the regular FP industrial procedure. It means applying the PRC as part of lamination using the adhesive application needed anyway for lamination.

The advantage is saving machine and manufacturing time and still enabling high performance retortable and microweble digital printed FP.

The PRC application in the lamination process is presented in scheme No 4. The PRC solution is mixed with the adhesive and no additional step to the FP manufacturing is necessary, as described in this scheme.



Scheme No. 4: The lamination process flow as – adhesive mixed with cross linker

The cross linker can be any cross linking molecule mixed in any off the shelf adhesive for high performance FP.

In order to mix the cross linker with the lamination adhesive the carrier solvent in which the cross-linker and adhesive are dissolved in has to be obviously the same carrier solvent.

Process:

An example of PET (polyethylene terephthalate 12 micron) and PET-Siox (high barrier PET with Siox embedded used for moisture and oxygen barrier) was primed with DP050 (Michelman, 0.18 gsm) and printed using EI with high ink coverage (350% including white) using ser. 4 digital printing machine.

Post printing, the film was laminated using a laboratory laminator (LaboCombi, Nordmeccanica) with a two component polyurethane solvent based adhesive from Morchem (Morchem PS 246 A + CS-95) mixed with the PRC cross linker (CL) (Indigicot S105™ from Lambson). All components dissolved in ethyl acetate. The adhesive 30% solid was prepared according to relevant TDS and 5% by wt. Indigicot S105™ was added to the total mixture. According to our experiment better results were achieved when the CL was added after all adhesive components were mixed. Lamination was performed immediately after the four component mixture was ready.

Laminate substrates were Alu(8mic)/OPA(15mic)/cPP(80mic) or OPA(15mic)/cPP(80mic), respectively to the printed substrate. Lamination conditions were: using the 3 ovens at 70,100 and 120°C temperatures, nip temperature at 60°C, lamination speed was 50m/min and both substrates (print and laminate) were corona treated with intensity of 1000W.

Measurements:

Lamination bond strength is a standard test to evaluate the performance of the laminate, (ASTM D1876.). The bond strength was for printed material with high ink coverage including white (total 350%). It is measured after the required curing time i.e. for two steps process 1d at 50°C after coating and 5d at 30°C after lamination and for the one step process 1d at 50°C+ 5d at 30°C after lamination.

Results:

Table 1: Post Lamination results

Sample preparation description	Printed substrate	Laminate substrate	Lamination Bond Strength: Patch #	Lamination Bond Strength: [N/inch]	Lamination Bond Strength: Failure
REF without PRC	Pet 12 micron	Alu/OPA/CPP	All Patches	3.5 ± 0.4	PT 30%
REF - two step process			All Patches	Tear	NA
One step			All Patches	Tear	NA
One step			All Patches	Tear	NA
REF without PRC	PET Siox 12 micron	OPA/CPP	All Patches	3.7 ± 0.5	PT 30%
REF - two step process			All Patches	Tear	NA
One step			All Patches	Tear	NA
One step			All Patches	Tear	NA

Table 2: Post retort results

Test	Printed substrate	Laminate substrate	Post Retort at 125°C for 30min – Lamination Bond Strength: Patch #	[N/inch]	Failure	Visual Inspections – Low ink coverage: Pouch area	Low ink coverage: Seal area	High ink coverage: Pouch area	High ink coverage: Seal area
REF no PRC	Pet 12micron	Alu/OPA/CPP	19-21	2	PT 30%				
REF - two step process			19	Tear	NA				
One step			19	Tear	NA				
One step			19	Tear	NA				
REF no PRC	PET Siox 12 micron	OPA/CPP	22/21	1.8/2	PT 50% -Tear				
REF - two step process			22	Tear	NA				
One step				Tear/CBO	NA				
One step			19	Tear	NA				

Tear - printed film tears during separating from laminate film and LBS cannot be measured. This results indicated very high bond strength between the two films.
CBO – "cannot be open" printed film cannot be separated from laminate film. LBS cannot be measured. This results indicated very high bond strength between the two films.
NA – not applicable
PT- partial transfer. During the separation of printed film from laminate film (LBS measurement) ink from printed film partially transfers to the laminate film.
Appurtenance (color code): **Green** – good, without imperfections
Yellow - moderate, some imperfections as small tunnels and minor delamination

Lamination Performance – One step vs. PRC released solution two steps

Lamination bond strength: Measuring the bonds between the printed and the second substrate allows to predict if the package will withstand the application. Especially for high end application, demanding bond strength is required since the thermal process and the heated food inserted into the package may reduce the laminate strength over time. As presented in tables above, laminated films resulted from the one step procedure resulted in the same performance before and after retort as the films resulted from the two step procedure, the benchmark samples, released PRC solution for high performance FP.

Thermal resistance: The primer-ink-adhesive interface strength and the ink cohesive strength are required to withstand the thermal process of sealing the pouch, pasteurization and retort. When the package is submerged in hot water (which is required for retort and pasteurization) the interfaces may separate and the laminate is not fit for use. In addition, LEP ink tends to melt at around 80°C, therefore sealing the films at the required temperatures (ranging from 140-220°C for 0.3-2 seconds) may cause color defects in the sealed areas. As for LBS, thermal resistance results of film resulting from both procedures present same good results and appearance.

Conclusion:

Cross linker application on LEP digital printed film to enhance the print for high performance application of FP is possible during the lamination process manufacturing step. Manufactured film in one step performance presented to be beneficial as in the released two step PRC solution both being superior to laminated film without cross linker.

Disclosed by Chen Zigdon, Liora Bruan and Einat Glick