Report on Nordmeccanica Open House

Packaging Films

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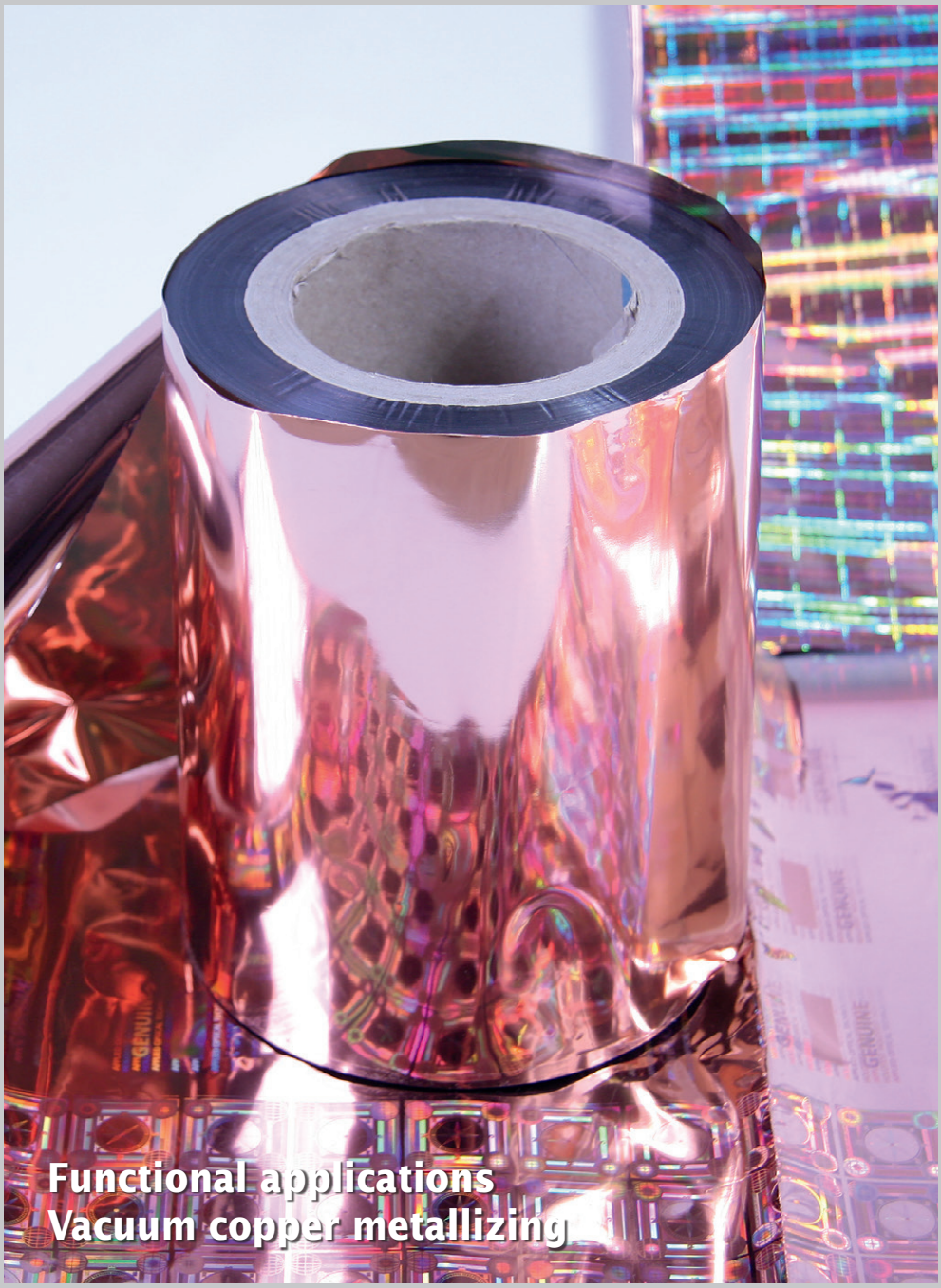

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Specific challenges of laminating – A practical guide for the everyday production

Ansgar Wessendorf, Karsten Schröder, Manfred Römer

Film manufacturing and laminating are complex processes where faults are part of the daily business. Especially in the area of flexible packaging which is made up of many individual aspects resulting in errors occurring in numerous different ways. Therefore, continued learning and the exchange of relevant information is a crucial prerequisite for almost faultless production processes. This article discusses the most common wrinkles in the laminating process, their causes and provides a "trouble shooting guide" with answers to frequently asked questions.

The problem of wrinkling

The problem of wrinkling is as old as the technology of laminating itself and is often caused by uneven quality in the respective base materials. Some different types of wrinkles and their possible causes are described below.

Horizontal wrinkles

These are caused by different lengths of the respective laminating materials and appear at the boundary area during the compounding stage. Horizontal wrinkles are attributed to the so-called »hanging edges« of one or several materials combined in the compound.

If such »hanging edges« are counterbalanced through the application of higher web tension the result is altered flatness temperature. This means the temperature where the hardened laminate lays flat is of huge importance for the converting process. If insufficient counterbalancing of the »hanging edges« and therefore no correct adjustment of the flatness temperature takes place, wrinkling occurs. The reason for leaving this undone is often due to the hop, that the winding tension will reverse wrinkling. However, this is definitely not the case as the wrinkles only get flattened and adhere in an uncontrolled way at best. Especially with barrier packaging such wrinkles may result in de-lamination of the compound film and thereby the decay of the filled goods.

Appropriate knowledge, strict incoming inspection and tolerance specification of the »hanging edges« may provide practical solutions for this problem. To achieve this several, though not standardised, processes are possible. The appropriate instructions can be obtained from Innoform.

Longitudinal wrinkles

The wrinkles in the running direction are caused either by faulty materials (sagging in the middle of the material roll) or by faulty machinery and false parameters respectively.

If thin materials like for example a 12 micron PET-BO is delivered with wrinkles included, there is no chance of debugging them retroactively. With thick or soft films spreading rollers may help if maximum tension is applied. But in this case the flatness temperature also has to be taken in to consideration.

The formation of longitudinal wrinkles is often caused by worn-out rollers, too high web tension or too coarse roller profiles for thin films.

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Summarising, the problem of wrinkling should not be underestimated in any way, as this is a matter of avoidable lamination faults with sometimes far-reaching consequences and therefore are not just flaws. Wrinkles may hamper the sealing of the packaging which may cause leaks and consequently the decay of the filled goods with eventual damage to the health of the consumer.

The problem of bubbling

The phenomenon of bubbling or lamination spots is unattractive and avoidable. There are many causes for such faults which are tolerated all too often as slight visual flaws. However, sometimes this is more than just bubbling but indicates faulty adhesion within the compound material, which in some cases may cause technical failure of the compound.

Under suitable illumination regular pinhead sized spots are visible which attribute to poor adhesive bonds within the compound material. If such bonds are not of consistent nature, contact transparency becomes lost with the ensuing consequence of visible colour shifting depending on hue and size of the bubbles. Although some

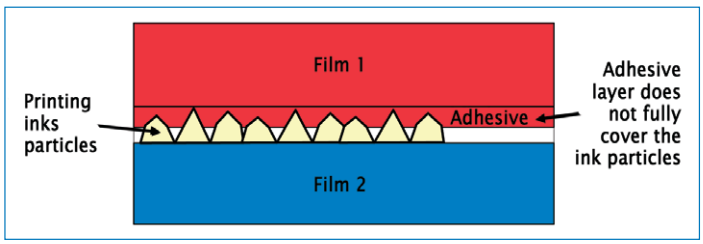


Figure 1: Diagram of the adhesive layer on a rough surface

of the bubbles disappear with solvent-based lamination this problem should not be underestimated.

Bubbles due to abrasive inks like white

This phenomenon especially occurs in white printed areas as the grey spots are clearly visible against the white background. This is a kind of pinholing relating to lost contact transparency mentioned above.

The use of inks containing very finely grounded pigments may contribute to avoiding such unwanted pinholes. This reduces the roughness of the ink layer which facilitates bubble free lamination also with thin adhesive layers (1.8-2.2 g/m² solventfree adhesive). Figure 1 is a diagram which shows the consequences of too low adhesion application onto a rough surface (for example printing ink). In this case, the adhesive layer does not fully cover the ink particles which also leads to bubbles.

From time to time it can happen that in some places no adhesive is applied at all. There can be many reasons for this, but it can be caused by factors such as false temperature control during application, improper laminating materials or printing inks with too low surface tension. To visualise this specific case, figure 2 shows areas with missing adhesive application.

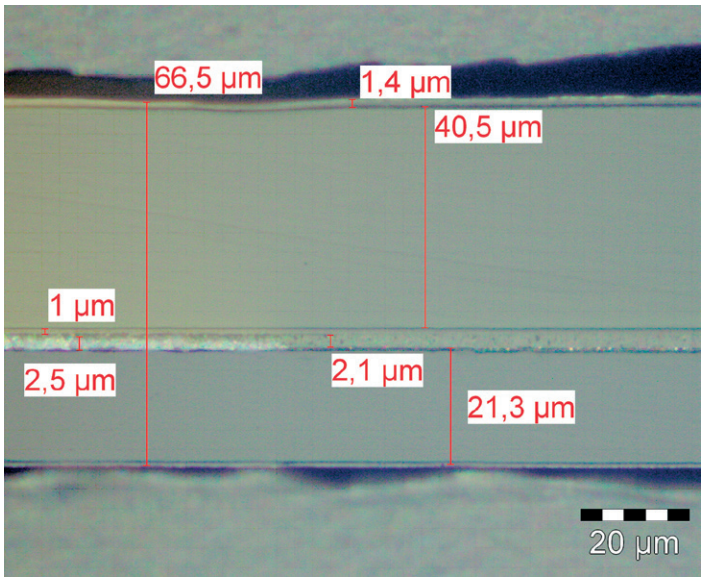


Figure 2: Areas with missing adhesive application

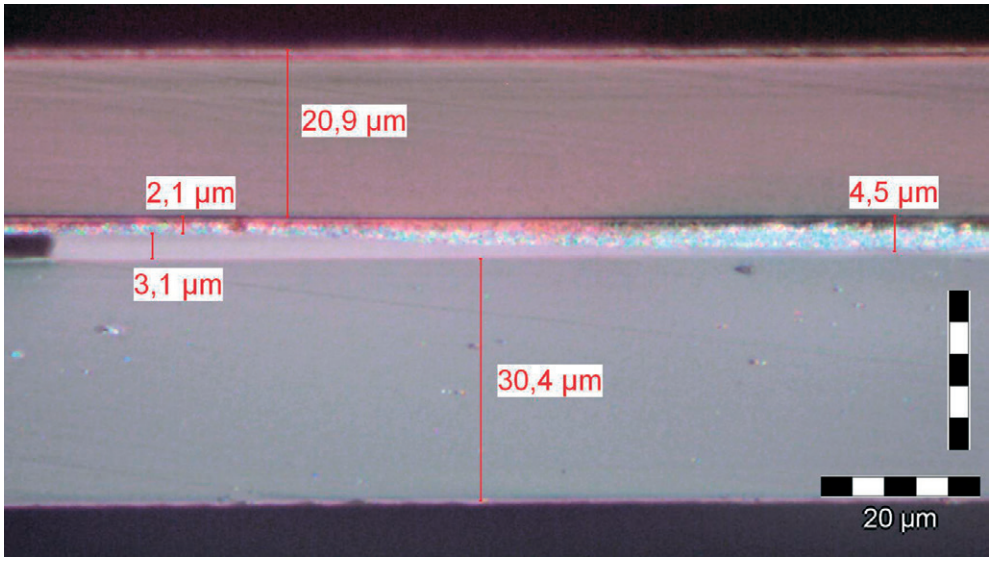


Figure 3: Missing adhesive application due to bubbles

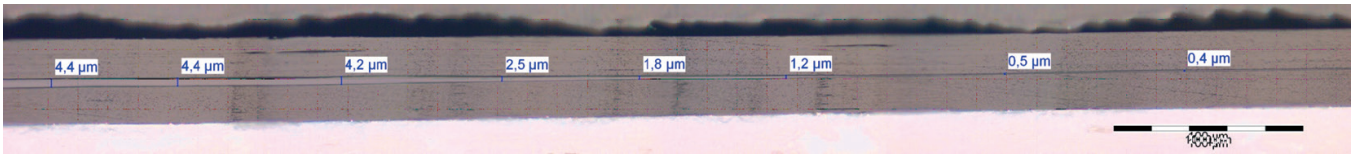


Figure 4: Drastic thickness variations of the adhesive layer

Bubbles due to gassing

Bubbles caused by the generation of CO_2 due to the chemical reaction of Polyol and aromatic Isocyanate look different than those caused by the aforementioned reasons. These bubbles are considerably bigger, and uneven in shape. They are characterised by a kind of bead at the edge of the bubble, which is attributable to the displacement of the adhesive by the gas. Due to its cohesiveness the adhesive gathers at the edge of the bubble creating a visible bead. This missing adhesive application due to bubbles can be seen in figure 3.

"When viewing the highly magnified area of an adhesive bond, often drastic thickness variations of the adhesive layer can be detected."

The same problem occurs with partial moistening disturbance caused by contamination of the surface or incorrect surface tension.

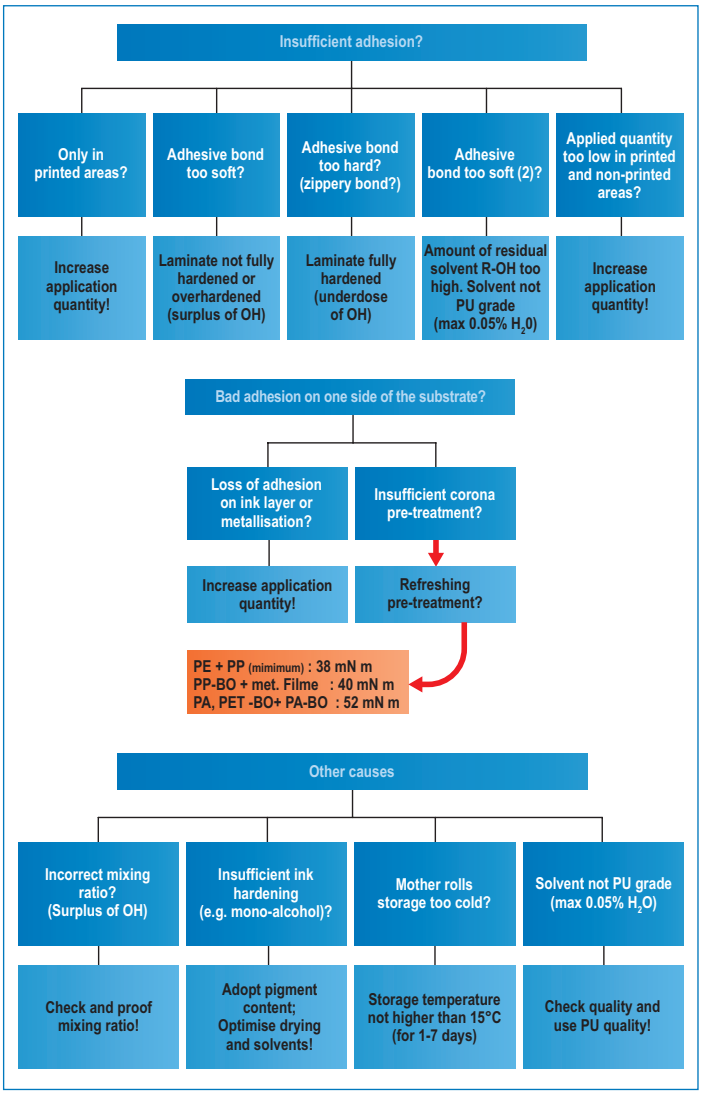
Bubbles due to uneven application in the micro range

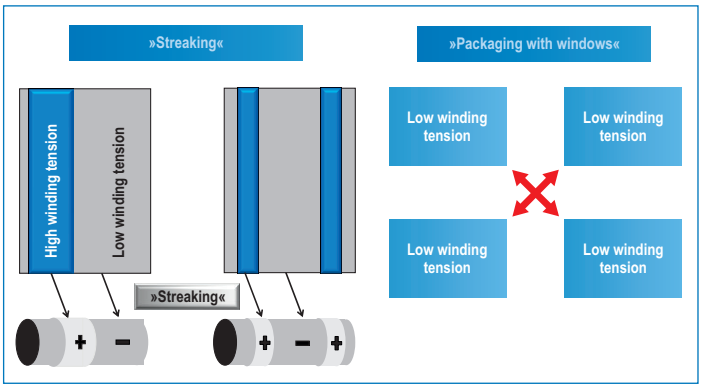
When viewing the highly magnified area of an adhesive bond (microtome cut), with the help of Multiple Imaging Alignment, often drastic thickness variations of the adhesive layer can be detected (figure 4).

For this example the thickness of the adhesive layer varies between 0.4 and 4.0 micron at a length of 0.5 mm (0.0196"). Such high fluctuations cannot be caused merely by incorrect rollers or bad printing inks but also by the roughness and tension of the respective substrate surface.

There are more possible solutions for this specific problem. A possible solution may be to check the products with a microscope to find the scale of such micro fluctuations and to see if the bubbles do occur. In such cases, a surface tension as high and even as possible may be achieved by refreshing the corona pre-treatment. Moreover, the viscosity of the adhesive may be varied through altering the temperature. In this context it should be kept in mind that different adhesives react in different ways with the same substrate and vice versa.

Laminates with insufficient adhesion and bad seal strength





Difficult print images

Bubbles caused by spots

Also spots in films, inks and adhesives may result in faulty lamination. But, nevertheless, such bubbles which are caused by spots occur less frequently per unit area and generally are considerably bigger than in comparison to bubbles caused by other reasons.

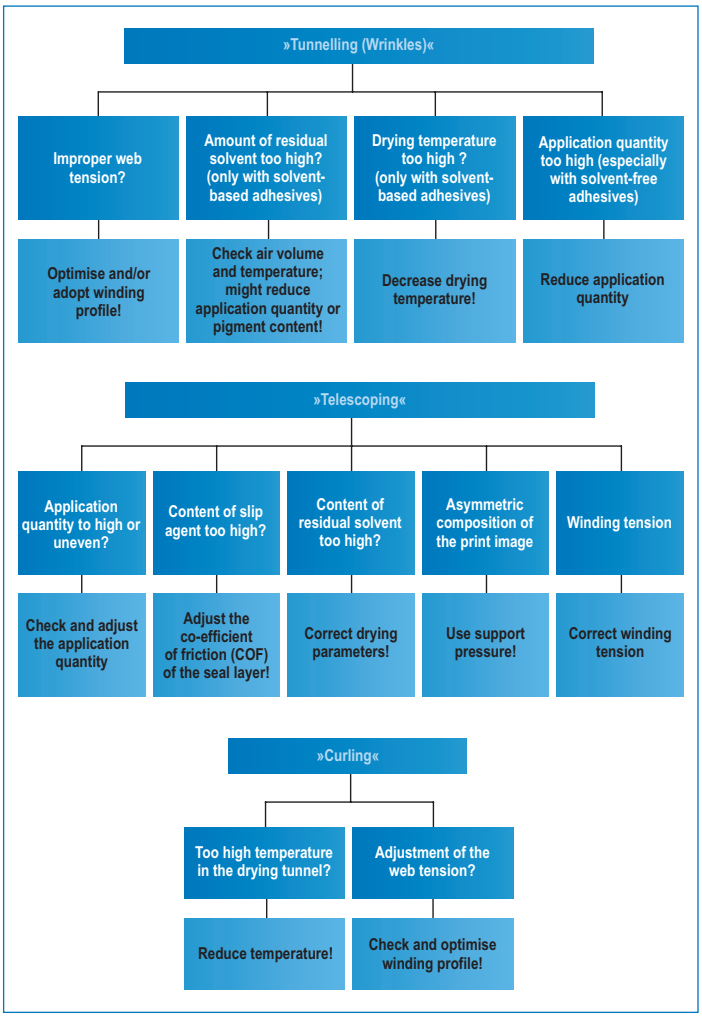
CO_2 gas bubbles

As mentioned above, bubbles may be caused by the generation of CO_2 due to the chemical reaction of Polyol and aromatic Isocyanate, the two main components of Polyurethane. Such bubbles may have a diameter of several millimetres. These CO_2 gas bubbles are also not perfectly round and unevenly distributed.

"CO_2 gas bubbles are found especially with gas barrier subrates like SiOx-coated or metallized films and EVOH barrier films."

These bubbles are found especially with gas barrier substrates like SiOx-coated or metallized films and EVOH barrier films. Manufacturers can maybe solve this problem either by using aliphatic adhesives or by reducing the application quantity.

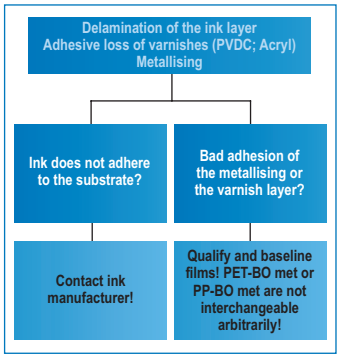
Moreover, it's useful to know that the adhesive system should not react too fast. If the system reacts too fast, the gas has not enough time to permeate into the outside and bubbles occur. Therefore, tempering and heat storage are mostly counterproductive measures.



Winding problems

Bubbles through enclosed air

The enclosing of air during lamination can also lead to bubbles. This is often caused by incorrect hardness of the impression rollers. If they are too hard, strong milling may affect the film compound. On the contrary, if the pressure is too soft, the air bubbles are not completely squeezed. In general, the optimum value for the hardness of the impression roller is about 80-90° Shore A. If the pressure is not too soft and not too hard, the problem of bubbles through enclosed air should not be occur in the most cases during the laminating process.



Delamination

Bubbles on the print edges

Very often bubbles are found at the edges of printed areas. If these edges are positioned in the running direction of the web, the winding pressure is lower there which allows the gasses enough place to gather. In such cases the so called supporting varnishing may be useful. This supporting vanishing is a transparent layer consisting of a blend (= ink without pigments). This layer even out the height tolerances in repeat and longitudinal directions.

Laminating – A "trouble shooting guide"

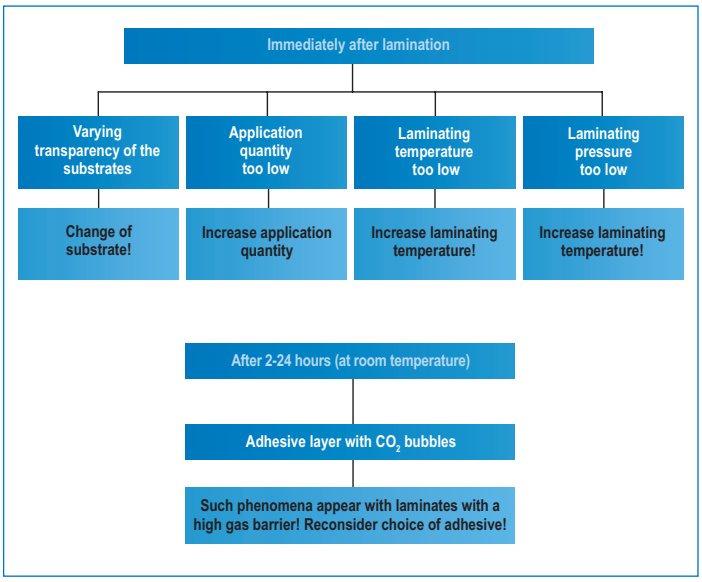
After summarizing the different possibilites of bubbles and its causes, the following part of the article offers a "trouble shooting guide" for the manufacturers of flexible packaging. This "trouble shooting guide" shall be used as practical guide for the everyday production . It offers concise advice on the cause of frequently occurring faults in the laminating process and suggests possible approaches.

"Our practical guide for the everyday production offers concise advice on the cause of frequently occuring fault in the laminating process."

The final stage of the production chain

Insufficient adhesion within the compound materials or bad seal strength are among the worst case scenarios for lamination companies as this makes further processing as with Form-Fill-Seal (FFS) machines virtually impossible. Unlike packaging the designer, film manufacturer and printer which have all performed their tasks, the laminating company is last in the production and converting chain. Until the cut reels or the finished bags are shipped, reliable and faultless lamination must take place. If faults occur during this final process, all the preceding efforts are in vain because faulty products cannot be shipped with-

Insufficient transparency



Adhesive viscosity

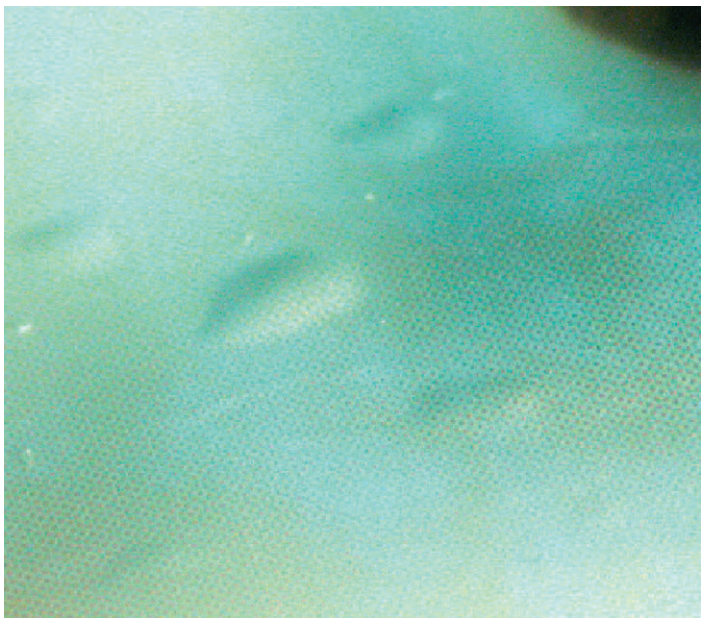


Figure 5: Bubbles caused by CO_2 generated through chemical reactions between the main components of Polyurethane

out the risk of indemnity claims from the filling companies.

This means that every participant in the production of packaging films must be aware, that such a worst case can only be avoided by employing the utmost care. Even if the faults were created during extruding or printing, at the lamination stage they can only be detected after several days. This is because the hardening of the adhesive – which depends on the storage temperature for the finished rolls – takes 5-10 days before the

"Even if the faults were created during extruding or printing, at the laminating stage they can only be detected after several days."

lamination process proves to be successful. For sure, there are several aids and tools to assure the quality of the lamination process. This includes the correct mixing ratio of the adhesive and its real characteristics during the production process. Not all items can be shown in this article, therefore just a part of the specific challenges of laminating can be find here.

Inks and adhesives

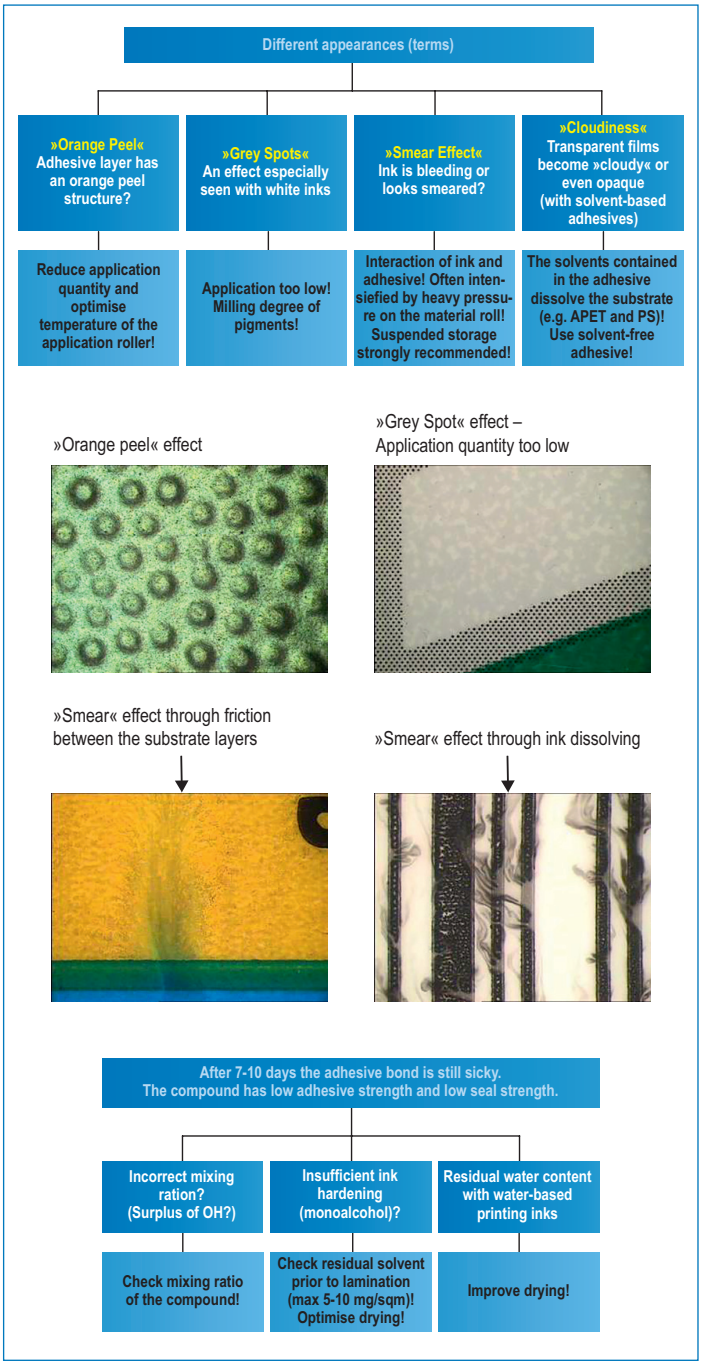
Often, laminating problems are caused by the printing process, because the various components of the inks may affect the characteristics of the adhesive. This occurs mostly in cases where the ink layer has not fully hardened. There are several measures to counteract this undesirable effect including:

- Job related choice of ink systems;
- Pre-treatment of film substrates (e.g. corona pre-treatment);
- Suitable choice of solvents;
- Ink viscosity during printing;
- Effectiveness of binding agents;
- Size of ink pigments (especially for white or mixed inks contenting white);
- Addition of suitable additives.

Solvent-based and solventfree lamination adhesives react very differently with printing inks. In general solvent-based adhesives are applied in higher quantities (g/sqm; dry), whereas solventfree adhesives can only be applied in very limited quantities due to their chemical properties. Solvent-based adhesives offer the possibility of compensating for the surface roughness of printing inks by increasing the application quantity. However, for solventfree adhesives this possibility is only applicable within a narrow range of tenths of millimetres which significantly limits the effectiveness of corrections or makes them completely ineffective.

Of course, complex operations such as the production of flexible packaging are always fraught with the risk of faults. Therefore, successful performance of the delicate process of lamination requires the observation of certain rules and continuous quality control at every step of production. In this context, the exchange of information between the producing companies and the suppliers is particularly important. In the following, some of these areas of information exchange are mentioned:

- Granulates;
- Lamination adhesives;



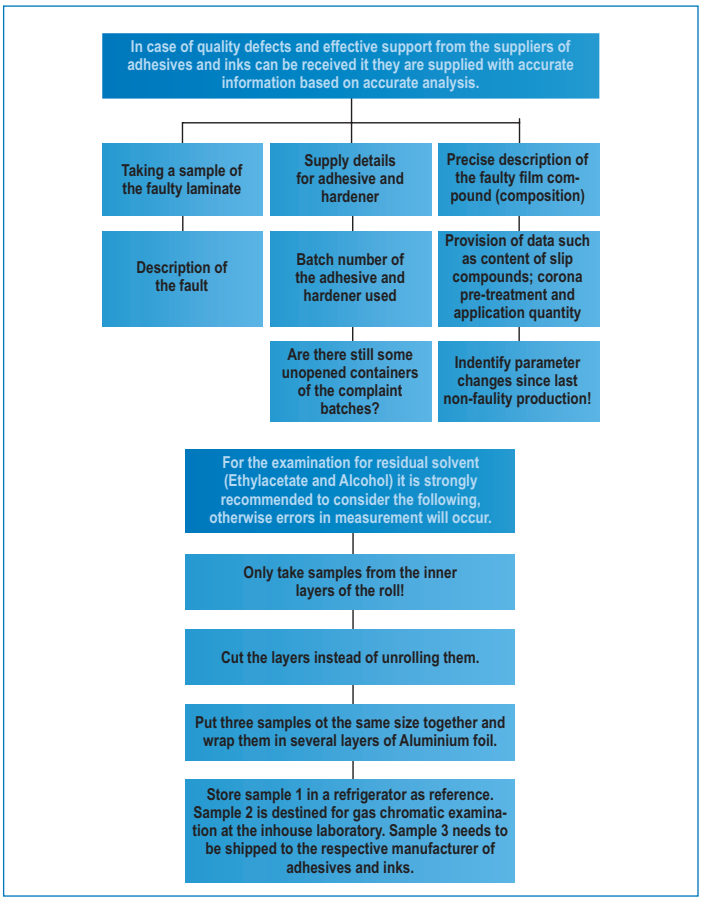
Other visual properties

- Master batches (important additives);
- Printing inks;
- Equipment for extrusion, printing and laminating;
- Auxiliaries such as solvents and cleaning detergents.

To ensure faultless production processes the suppliers are obliged to provide their customers with all the relevant information and not hold back under the pretext of supposed business secrets.

Conclusion

In the manufacturing of flexible packaging, faults can be avoided if all elements are at the same expertise level. To avoid failures, intensive and systematic fault analysis is necessary. It is hardly helpful to send out accusations via telephone or e-mails, it is more important to be able to identify the actual problem. The description of the possible problems of wrinkling and bubbling and its causes as well as the "trouble shooting guide" shall serve as an aid for fault analysis in the daily bussiness.



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