Extrusion coating and lamination

Extrusion coating and lamination

Paperboard is coated with plastics to combine the mechanical properties of the paperboard with the barrier and sealing properties of plastics. Paperboard combined with a relatively small number of plastic materials will provide the extra features needed to make the paperboard suitable for a number of specially demanding applications.

Extrusion coating is a process whereby molten plastic is applied to paperboard and subsequently chilled to form an extremely thin, smooth layer of uniform thickness.

The molten plastic can be used as an adhesive to laminate a plastic film or a metal foil.

Extrusion coating and lamination are used to achieve:
- moisture protection
- barrier to water vapour, oxygen, aroma, etc.
- grease resistance
- heat sealability
- sales appeal, for example shiny surfaces.

Sales appeal
The use of extrusion coated and laminated paperboard provides outstanding promotional benefits in terms of visual appeal and consumer handling.

High gloss is created by extrusion coating and a specific high gloss chill roll. A metallic effect is created by lamination with aluminium foil or metallised polyester film. These materials and processes also provide tactile sensations of high quality and luxury which the consumer associates with high value products packaged in these materials.

Examples of extruded and laminated products providing sales appeal
- PE (polyethylene) extrusion coating of paperboard with a gloss or matt finish. Printing and gluing (with cold glue) can be done on a corona-treated surface.
- PP (polypropylene) and PET (polyethylene terephthalate) are two heat resistant polymers that, applied on the board, can be used in oven applications.
- Aluminium foil and metallised polyester film may be laminated to the paperboard to provide a metallic effect. Printing can be done on a pre-treated surface.

Functional coating
Paperboard as such is suitable for the packaging of dry products in general. However, plain paperboard is only suitable for direct contact with moist and greasy foods to a limited extent, because moisture will affect the mechanical properties of the paperboard, and absorbed grease will cause stains. Such effects will obviously reduce the protective function of the package and may detract from the appearance as well.

Extrusion coating or lamination adds a thin layer of plastic to the paperboard. Plastic coatings can provide resistance to grease and moisture and, where appropriate, be heat resistant. Plastic coatings can be heat sealed and in some constructions these seals can be leak proof. Depending on the application, the paperboard may be extrusion coated on one or two sides.

Aluminium lamination provides packages with a barrier to light, moisture, grease and gases. The aluminium foil is often plastic coated to provide product safety and heat sealing abilities.

Key characteristics
A number of process parameters influence the grammage of the coating. The most important are:
- flow of the plastic melt
- temperature of the plastic melt.
### Application

<table>
<thead>
<tr>
<th>Applications</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquids</td>
<td>Ice cream and soft drinks require a good water barrier. Two side extrusion coatings are often required to maintain the rigidity of the cups. First class runnability in the cup forming machine is an absolute necessity.</td>
<td>Drinking cups</td>
</tr>
<tr>
<td>Frozen foods</td>
<td>Frozen foods which are pre-frozen and packed as such can usually be packed in one-side plastic coated paperboard. Other products, which are packed wet and even hot for chilling and freezing in the package, will generally require a two-side plastic coated paperboard to ensure that the package functions reliably all the way to the consumer.</td>
<td>Ice cream</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frozen vegetables</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Seafood</td>
</tr>
<tr>
<td>Ovenable packs</td>
<td>The packaging material must resist moisture and grease at elevated temperatures without penetration into the paperboard. The paperboard is given a heat-resistant plastic coating, which must not affect the taste or odour of the food.</td>
<td>Baking using the packages as a baking mould</td>
</tr>
</tbody>
</table>
Extrusion coating and lamination machine

1. Unwinding
The paperboard is loaded into an unwinding position.

2. Surface treatment
The paperboard surface is pre-treated with an electrical corona discharge. The plastic film can be treated with ozone. These methods increase the adhesion of the plastic to the paperboard.

3. Extrusion coating
Plastic granules such as polyethylene (PE), polypropylene (PP) and polyethylene terephthalate (PET) are converted by pressure and heat to the molten state in the barrel of the extruder. The molten plastic passes through a narrow slit in the automatically controlled die and onto the surface of the paperboard. The control of temperature is critical. The plastic surface is immediately pressed against the chilled face of a steel roll, controls the finish of the plastic surface. Reverse-side coatings have an NSO (Non-Set-Off) finish and print-side coatings usually have a gloss finish.
4. Extrusion lamination
An unwind station is located immediately after the initial plastic coating is applied. Foil or film can be fed from this position into the nip between the molten plastic film and the chill roll such that the plastic initially performs the functions of an adhesive.

5. Corona treatment
Print-side plastic coatings are subjected to corona treatment to achieve good ink wetting. One-side plastic coatings are also corona treated to improve the sealing characteristics and permit gluing with emulsion adhesives.

6. Reel-up
The paperboard is wound onto large steel cores (drums) in batches of between 1 and 3 tonnes depending on the product. Each drum is given a unique in-house identification code.
Extrusion coating and lamination materials
The materials used for extrusion coating and extrusion lamination are paperboard, paper, plastic resins, plastic films and aluminium foil.

There are many types of coating resins and many of them have special features for specific end user applications. Film and foil suppliers produce both standard interchangeable products as well as their own speciality niche products. These can be combined with paperboard to create a great variety of products.

Plastic coating resins are selected for very low taint and odour properties so that the packed products will not be affected.

European waste legislation stipulates that packaging material should be easily separable to enable recycling when possible. The plastic layer on extrusion coated material is by nature difficult to separate from the board, which makes it difficult to comply with these regulations. Mono materials, which are made from one basic raw material, are sometimes seen as better alternatives than composites such as extrusion-coated paperboard. Composites exist because they are efficient and reliable in providing the required functions. Promoting mono materials usually means sacrificing functional performance and adopting packaging materials with significantly lower efficiency.

However, if the amount of the plastic barrier is below a certain level (currently 5% of the total weight) the packaging material is regarded as a mono material from a tax point of view. There are well-proven processes in use today that can separate plastics and foils from the fibres. These fibres can then be used for the production of recycled fibre products. To facilitate recycling and maintain the quality of the recycled materials, it is always an advantage to sort at the source.

Key properties required for extrusion coating and lamination:
• surface properties such as structure, smoothness, strength and profile
• surface strength properties such as z- and tearing strength and stiffness
• hydroscopic properties such as moisture, flatness and dimensional stability
• flatness and dimensional stability
• cleanliness of edges and surface
• polymer adhesion
• odour/taint neutrality.

Key properties for glue lamination:
in addition to the above
• surface water absorption
• gluability.

<table>
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<tr>
<th>Raw material</th>
<th>Additional properties</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene (PE)</td>
<td>Good moisture barrier and sealability.</td>
<td>Frozen food, ice cream, cups and confectionery.</td>
</tr>
<tr>
<td>Polypropylene (PP)</td>
<td>Good grease and moisture barrier. Resists high temperatures and is sealable.</td>
<td>Ready-made food for reheating in the package.</td>
</tr>
<tr>
<td>Polyethylene terephthalate (PET)</td>
<td>Very good grease resistance at elevated temperatures. The amorphous coating is heat sealable and heat resistant.</td>
<td>Trays for reheating and for baking.</td>
</tr>
<tr>
<td>Aluminium foil</td>
<td>Good flavour barrier and smooth surface with high gloss.</td>
<td>Luxury products and chocolates.</td>
</tr>
<tr>
<td>Metallised PET film</td>
<td>Very high gloss and good printing characteristics. Good flavour barrier.</td>
<td>Gifts, wines and confectionery.</td>
</tr>
</tbody>
</table>
Additional coating properties
The strength characteristics of the paperboard are slightly changed after extrusion coating and lamination. Plastic coating with low density PE does not alter the stiffness but PP or PET coatings will increase the stiffness considerably. The toughness of the resin gives increased tear strength to plastic-coated paperboard.

Plastic adhesion
Plastic adhesion is a dimensionless property defining the relationship between the adhesive and cohesive strength of the paperboard surface. The bonding should ideally be higher than the internal bond of the paperboard in order to create fibre tear. See Test Method in the Gluing chapter.

Adequate adhesion is important for most converting operations, such as printing and heat sealing. For production control an internal method is used. The plastic coating or film is pulled off at specified angles and the degree of fibre tear is determined. The ranking is: 6 = 100 % fibre tear, 1 = no fibre tear.

If the strength of the paperboard/pigment coating is stronger than the bond between the paperboard and the plastic coating, no fibre tear is achieved (e.g. fully pigment-coated paperboard). Then a different scale of evaluation is applied and the ranking is: 6 = excellent adhesion, 1 = weak adhesion. In these cases the adhesion can also be measured as peel strength at a 125 ° angle. The result is expressed as N/cm width.

The plastic adhesion is mainly governed by:
- surface properties of the baseboard
- pre-treatment of the baseboard (corona and ozone)
- heat content of the plastic melt when applied to the paperboard.

Corona treatment is necessary when:
- The plastic surface is to be printed (to enable the ink to wet the surface).
- Emulsion glue is to be used (to enable the glue to wet the surface).

Corona treatment also improves heat sealability. Two-side corona treatment is not available because such a material would give severe blocking problems between the sheets. The corona-treated plastic surface is extremely sensitive. Any rubbing, touching by hand, etc. will destroy the treatment.

During production the corona level is mainly affected by mechanical damage. The moisture content of the paperboard can also influence the level. For two-side PE-coated paperboard we strongly advise never to stack more than two pallets high.

Pinholes
Pinholes are microscopic holes that might appear in the plastic film during the coating process. In most cases, a limited number of pinholes is acceptable. The main reasons for the appearance of pinholes are irregularities in the base paperboard (too high surface roughness, loose fibres, etc.), an uneven coating profile or too low a plastic grammage.

Measurable properties

Pinholes
Coloured denaturised alcohol is applied on the test surface. After 5 minutes the remaining liquid is wiped off. Pinholes are indicated from the reverse side as green spots. The number of pinholes is expressed as number/m².