Workshop: Procurement of Packaging for Exports
Guyana, April 19-23, 2010

Session 4:
Plastic Packaging Films & Laminates; Properties, Specifications & Purchasing

Executing/Host Partner: GUYANA
Supporting Partners:

Supported with funding from:

Canadian International Development Agency
Agence canadienne de développement international
Product Considerations

- Type/nature of the product
- Quantity/weight/volume to be packed
- Critical attributes/characteristics
- Packing method and conditions
- Product protection requirements – physical, climatic, biological, security, etc.
Commercial Considerations

• Quantities required/ordered
• Delivery required/agreed
• Packing & shipping instructions
• Reel winding & print position
• Pricing, if agreed
• Delivery clause/insurance/terms of payment
Technical Considerations

- Designation of the pack (type, style, if known)
- Pack raw material(s): grade, quality, weight
- Construction of pack, if known
- Relevant dimensions & tolerances
- Special features/properties/accessories
- Graphic design/printing
- Applicable standards & test methods
# Film and Flexible Packaging Options

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single and multi-layer films</td>
<td></td>
</tr>
<tr>
<td>Aluminium foils and metallized films</td>
<td></td>
</tr>
<tr>
<td>Film/foil/paper laminates and their applications</td>
<td></td>
</tr>
<tr>
<td>Sealing materials for films and laminates</td>
<td></td>
</tr>
<tr>
<td>Form-fill-seal processes and pouch styles</td>
<td></td>
</tr>
<tr>
<td>Specification of flexible packaging laminates</td>
<td></td>
</tr>
</tbody>
</table>
### Types of Plastic - Polyethylenes

Differences in molecular arrangement produce several different polyethylene families.

<table>
<thead>
<tr>
<th>Polyethylene Class</th>
<th>Density Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>low-density polyethylene (LDPE)</td>
<td>0.910 to 0.925</td>
</tr>
<tr>
<td>linear low-density (LLDPE)</td>
<td>0.915 to 0.935</td>
</tr>
<tr>
<td>high-density polyethylene (HDPE)</td>
<td>0.942 to 0.965</td>
</tr>
</tbody>
</table>

HDPE and LDPE properties and applications are so different that they are best considered as different polymers.
HDPE Properties

- Low cost, easily processed
- Low softening and melting points
- Compatible with foods and most household chemicals
- Tends to be translucent
- Good moisture barrier, poor oxygen barrier
HDPE Packaging Applications

**Film:**
- some industrial and carry-out bags
- drum and box liners
- some laminates

**Three dimensional:**
- household and industrial chemical containers (HIC)
- tubs (freezer)
- crates and totes
- pails and drums
## LDPE Properties

<table>
<thead>
<tr>
<th>Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low cost, easily processed</td>
</tr>
<tr>
<td>Films are soft and clear</td>
</tr>
<tr>
<td>Lowest softening and melt point (good for heat-sealing)</td>
</tr>
<tr>
<td>Compatible with most foods and household chemicals</td>
</tr>
<tr>
<td>Fair moisture barrier, very poor oxygen barrier</td>
</tr>
<tr>
<td>Very high elongation (desirable for stretch wrap)</td>
</tr>
</tbody>
</table>
LDPE Packaging Applications

Film:
- stretch wrap (Linear low density - LLDPE)
- heat seal film/coating
- bags and liners
- shrink film

Three dimensional parts:
- squeezable bottles
- caps and closures (high flexibility)
LDPE Bags for Fresh Grapes, Chile

• Highly transparent, glossy LDPE to highlight product
• Flexo print, two & three colour
• Trilingual copy
• Different suppliers, same product code
LDPE Bag with Header Card
Zimbabwe

- White pigmented LDPE bag for 50 tea bags
- Printed single colour flexo
- Board Header Card carries multi-colour decoration and variable
- Stapling card to bag not acceptable for export
Polypropylene (PP) Properties

- Low cost, easily processed, good chemical compatibility
- Three dimensional parts translucent, so colorants added
- Oriented PP (OPP) film is clear, stiff and glossy,
- Unoriented PP becomes brittle at low temperatures
- Good moisture barrier, poor oxygen barrier
- Forms best “integral hinge” when moulded
- Higher softening point than PE (can be hot filled)
PP Packaging Applications

**Film:**
- food pouches and bags (most snack foods)
- clear wraps
- clear label stock
- often metallized and printed

**Three dimensional parts:**
- dairy tubs, moulded or thermoformed closures
- blow moulded bottles
- jewel boxes and integral-hinge packs
Polystyrene (PS) Properties

- Hard, stiff, brittle, and crystal clear
- Can be modified to provide more impact resistance
- Readily expanded with gases to make expanded PS
- Poor solvent resistance (can be solvent bonded)
- Poor overall barrier properties
PS Packaging Applications

**Film:**
mostly in the form of expanded PS label stock

**Three dimensional parts:**
jewel boxes (for example CD cases)
some jars, bottles, and closures
some cosmetic containers and parts
expanded PS trays and protective packaging
thermoformed or injection moulded cups and tubs
Polyethylene Terephthalate (PET): properties and Applications

- Highest tensile strength of packaging polymers
- Good moisture and gas barrier
- Low elongation
- Can be made clear or translucent
- Crystallized form (CPET) has high use temperature

Film: High strength applications, ovenable applications
Three dimensional: Clear bottles for beverages, etc.
### Relative Properties of the Main Barrier Plastics

<table>
<thead>
<tr>
<th>Plastic Material</th>
<th>Water vapour</th>
<th>Oxygen</th>
</tr>
</thead>
<tbody>
<tr>
<td>high-density polyethylene</td>
<td>very good</td>
<td>poor</td>
</tr>
<tr>
<td>ethylene-vinyl alcohol</td>
<td>absorbs water, excellent</td>
<td>excellent</td>
</tr>
<tr>
<td>poly(vinylidene chloride)</td>
<td></td>
<td>poor</td>
</tr>
<tr>
<td>polystyrene</td>
<td></td>
<td>poor</td>
</tr>
</tbody>
</table>
## Oxygen Barrier Comparison

(\text{cc} /0.001 \text{ inch}/100 \text{ inch}^2/24 \text{ hr})

<table>
<thead>
<tr>
<th>Material</th>
<th>Barrier (cc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ethylene-vinyl alcohol (EVA)</td>
<td>0.02</td>
</tr>
<tr>
<td>polyvinylidene chloride (Saran)</td>
<td>0.2</td>
</tr>
<tr>
<td>polyamide (Nylon)</td>
<td>3</td>
</tr>
<tr>
<td>polyethylene terephthalate (PET)</td>
<td>5</td>
</tr>
<tr>
<td>high-density polyethylene (HDPE)</td>
<td>110</td>
</tr>
<tr>
<td>Polypropylene (PP)</td>
<td>150</td>
</tr>
<tr>
<td>low-density polyethylene (LDPE)</td>
<td>480</td>
</tr>
</tbody>
</table>
## Water Vapour Barrier Comparison

<table>
<thead>
<tr>
<th>Material</th>
<th>g/100² in/24 hr at 90%RH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyvinylidene chloride (Saran)</td>
<td>0.05</td>
</tr>
<tr>
<td>High-density polyethylene</td>
<td>0.3</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>0.4</td>
</tr>
<tr>
<td>Low-density polyethylene</td>
<td>1.2</td>
</tr>
<tr>
<td>Polyethylene terephthalate</td>
<td>1.3</td>
</tr>
<tr>
<td>Polyvinyl chloride</td>
<td>4</td>
</tr>
<tr>
<td>Polyamide (nylon)</td>
<td>25</td>
</tr>
<tr>
<td>Ethylene-vinyl alcohol</td>
<td>absorbs water</td>
</tr>
</tbody>
</table>
## Relative Physical Properties of Plastics

<table>
<thead>
<tr>
<th></th>
<th>Tensile</th>
<th>Elongation</th>
</tr>
</thead>
<tbody>
<tr>
<td>polyethylene terephthalate</td>
<td>high</td>
<td>low</td>
</tr>
<tr>
<td>oriented polypropylene (OPP)</td>
<td>high</td>
<td>low</td>
</tr>
<tr>
<td>polyamide (nylon)</td>
<td>medium</td>
<td>medium</td>
</tr>
<tr>
<td>polypropylene, unoriented</td>
<td>medium</td>
<td>medium</td>
</tr>
<tr>
<td>high-density polyethylene</td>
<td>medium</td>
<td>medium</td>
</tr>
<tr>
<td>low-density polyethylene</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td>linear low-density polyethylene</td>
<td>low</td>
<td>high</td>
</tr>
</tbody>
</table>
# Maximum Use Temperatures

<table>
<thead>
<tr>
<th>Plastic Material</th>
<th>Max. use temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>polyethylene terephthalate</td>
<td>204</td>
</tr>
<tr>
<td>polyamide (nylon)</td>
<td>177</td>
</tr>
<tr>
<td>polypropylene (unoriented)</td>
<td>116</td>
</tr>
<tr>
<td>high-density polyethylene</td>
<td>100</td>
</tr>
<tr>
<td>polyvinyl chloride (PVC)</td>
<td>93</td>
</tr>
<tr>
<td>linear-low density polyethylene</td>
<td>77</td>
</tr>
<tr>
<td>low density polyethylene</td>
<td>66</td>
</tr>
</tbody>
</table>

Celsius
<table>
<thead>
<tr>
<th>Plastic Polymer Additives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process stabilizers (heat stabilizers)</td>
</tr>
<tr>
<td>Environmental stabilizers (anti-oxidants, UV stabilizers)</td>
</tr>
<tr>
<td>Surface modifiers (slip agents, anti-static, anti-blocking)</td>
</tr>
<tr>
<td>Optical modifiers (pigments, nucleating agents)</td>
</tr>
<tr>
<td>Functional additives (mechanical property enhancers)</td>
</tr>
</tbody>
</table>

(Note that no producers make exactly the same polymer)
Film Orientation

Most plastic packaging films are oriented

Consists of stretching the film in one (monoaxial, eg. OPP) or two (biaxial, eg. BOPP) directions

Orientation dramatically improves properties such as stiffness and tensile strength while reducing elongation

Orientation increases film yield
Why Laminate?

Laminate: A product made by bonding together two or more materials, whether plastic, paper or foil.

There is no perfect, universal packaging material.

Laminates assemble materials with individually desirable properties to create an optimum combination.

Note: Packaging laminate plies are listed from the outside to the inside.
Cast Film and Sheet Extrusion

Extruder

Extrusion Die

Adjustable Die Lips

Adjustable Pressure ( Restrictor) Bar

Extruder #1

Extruder #2

Extruder #3

Material #1

Material #2

Material #3
Multi-layer Plastic Laminate Pouch for Herbs

- PP/EVA/PE transparent, positive pressure, gas-tight pouch
- Flexo printed, 4 colour
- Clear window to display product
- Rosemary exported from Dominican Republic
# Laminate Mechanical & Barrier Properties

## Mechanical properties – as required
- Tensile strength
- Stiffness
- Coefficient of friction
- Use temperatures
- Elongation
- Formability

## Barrier properties - as required
- Oxygen barrier
- Essential oil barrier
- Water vapor barrier
- Light barrier
# Laminate Sealing & Appearance

## Sealability
- most flexible packaging is heat sealed
- most heat seals are polyethylene based
- ionomer (Surlyn) used for difficult seals

## Aesthetic appearance
- clarity
- surface gloss
- reflective metallics
## Aluminium Foils for Laminates

<table>
<thead>
<tr>
<th>Description</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household foil is typically 17.5 μm (0.0007 inches)</td>
<td></td>
</tr>
<tr>
<td>Available in gauges as low as 7 μm (0.00028 inches)</td>
<td></td>
</tr>
<tr>
<td>Pin holing is likely below 12 μm (0.0005 inches)</td>
<td></td>
</tr>
<tr>
<td>Foil is susceptible to flex cracking when folded</td>
<td></td>
</tr>
<tr>
<td>Most foils are supported with plastic and/or paper</td>
<td></td>
</tr>
</tbody>
</table>
## Aluminium Foil Characteristics

<table>
<thead>
<tr>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intact foil is a 100% barrier to all gases &amp; moisture</td>
</tr>
<tr>
<td>Best deadfold properties</td>
</tr>
<tr>
<td>Easily punctured (tamper evidence)</td>
</tr>
<tr>
<td>Reflects radiant heat</td>
</tr>
<tr>
<td>Decorative appeal: all reflective metallics are aluminium</td>
</tr>
</tbody>
</table>
Al. foil/plastic laminate, Tajikistan

- Soft-drink pouch materials ready for installation on HFFS machine
- PP/Al/LDPE laminate
- Flexo reverse printed. 4 colour
- Laminate imported on reel from Dubai
Al. foil/plastic bags, China & Iraq

- PP/Al. foil/PE laminate pouches for loose tea
- 2 – 3 colour flexo reverse printing on PP
Al. Foil/Plastic Laminate for Pastes

- PP/Al/PE gussetted squeeze pouch with screw cap for marron paste, France
- Flexo reverse printed on PP, 4 colour
- Sold in 4-unit board display pack
Aluminium Metallized Film and Paper

- Provides reflective metallic appearance
- Improves some film barrier properties, eg. light fastness
- Oxygen barrier improved: up to fifty times for OPP, up to ten times for PET
- OPP, PET, & PA (nylon) are the most commonly metallized packaging films

Does not match foil laminate barrier properties
Metallized plastic pouches for snacks

- Laminated metallized PP/PE stand-up pouches
- Flexo reverse printed on PP, 4 colour process
- Transparent inks to show metallic shine
Common Heat-Seal Materials

High performance

- ionomer (e.g. Surlyn, seals through contaminants)
- metallocene polyethylene (fast low temperature seal)
- LLDPE (good hot tack, tough, wide seal temp.range)
- PE/EVA (soft film, low seal temperature)
- medium-density polyethylene (stiffer, better barrier)
- cast polypropylene (stands higher temperatures)
- low-density polyethylene (lowest cost)

Cost & Bond Quality

Low Performance
Examples of Laminations

Retort pouch
polyethylene terephthalate
foil
sealing medium

Snack food bag
printed polypropylene
metallized polypropylene
sealing medium

Aseptic box
polyethylene
printed paper
foil
sealing medium

Luncheon meat tray
saran-coated nylon
sealing medium (Surlyn)
## Film Thickness Measurement

<table>
<thead>
<tr>
<th>Inch</th>
<th>Gauge</th>
<th>Mil</th>
<th>Micrometre</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.001 inch</td>
<td>100</td>
<td>1</td>
<td>25 μm</td>
</tr>
<tr>
<td>0.0005 inch</td>
<td>50</td>
<td>1/2</td>
<td>13 μm</td>
</tr>
<tr>
<td>0.002 inch</td>
<td>200</td>
<td>2</td>
<td>51 μm</td>
</tr>
</tbody>
</table>

**ISO metric notes:**
- “Micron” is an abbreviation for micrometre
- one inch = 25.4 millimetres and
- 0.001 inch = 25.4 micrometres