New Technology in Postharvest Plastics

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Postharvest Horticulture Plastics

- **Bulk packages** (for harvest and transport)
  - Plastic bins
  - Returnable plastic containers (RPC)
  - Corrugated plastic containers
- **Consumer packages**
  - Flexible and rigid containers
  - Modified atmosphere packages (MAP)

Plastic Waste

- **Facts**
  - The average per capita plastic waste per year in the USA is 185 pounds
  - Plastic accounts for about 10% of the total waste generated in the USA
  - Worldwide, about 500 billion plastic bags are used per year
  - Virtually every bit of plastic ever made still exists in some shape or form, minus the small amount incinerated
- **Solutions**
  - Recycling - #1 (PETE) and #2 (HDPE) are the most commonly recycled plastics
    - Plastic bags and polystyrene foam have very low recycling rates
  - Alternatives – starch, cellulose and other plant-based biopolymers that mimic plastics

Bioplastics

- **Definition** – made from natural materials, such as corn and potato starch, sugar cane, and cellulose
- Made from renewable resources. The Appearance of some bioplastics is virtually indistinguishable from traditional petrochemical plastics
- Bioplastics are typically designed to be biodegradable or compostable
- **Examples:**
  - Polylactic acid (PLA) or polylactide (PLLA/PLDA) and cellulose acetate
  - Excess potato starch (waste stream) used to produce resins that can be utilized in packaging
  - Sugar cane used to produce LLDPE and HDPE that process and perform like traditional plastics

(Bio)Degradable Plastics

- **Definition:** Degrade naturally in the environment
- Degradable plastics are made from petrochemicals with specific *additives* that are engineered to facilitate break down
- **Examples:**
  - Photodegradable and oxy-degradable grocery bags and garbage bags

Compostable Packaging

- Postharvest packaging derived from renewable raw materials like starch and cellulose
- Manufacturers must have scientific evidence that the materials in the item break down, or become part of, usable, compost in a safe and timely manner in an appropriate composting facility or home compost pile.
- *For example*, polylactic acid (PLA) and cellulose

Biodegradable ⇏ Compostable

- “Biodegradable” plastics that are made from petrochemicals plus additives “break down” into non-organic substances (i.e., not “compost”).
- Only biodegradable plastics that break down into organic substances under the conditions and within the timeframe of normal composting are “compostable.”

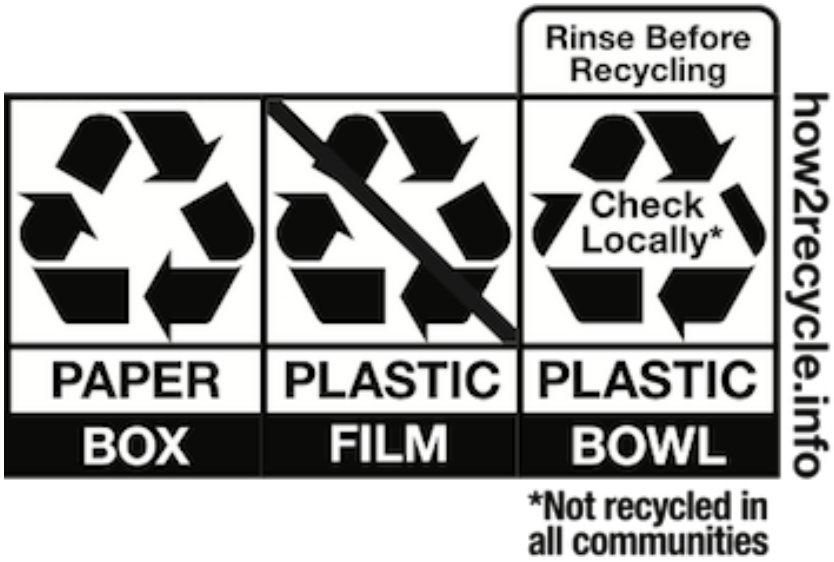
Recyclable Packaging

- Plastic recycling means recovery of scrap or waste plastic and re-processing the material into useful products
- Resin Identification Code (RIC) – identifies the plastic resin out of which the product is made
- Examples:
  - PET #1 – (R-PET, PCR) made into bottles, trays, films, clothing, building materials
  - HDPE #2 – made into bottles, tables, roadside curbs, benches
  - Agricultural plastics like mulch, drip tape, and silage bags are converted into much larger products for industrial applications, like plastic composite railroad ties

- **Only about 10% of recyclable plastics are recycled due to lack of demand for the product.**

Recyclable Packaging

- Resin & technology improvements: PE/PE laminate is similar to OPP/PE laminate. This "new" film has created a new designation:
  - Recycle Ready or Store Drop Off Recycling
  - A designed end-of-life use

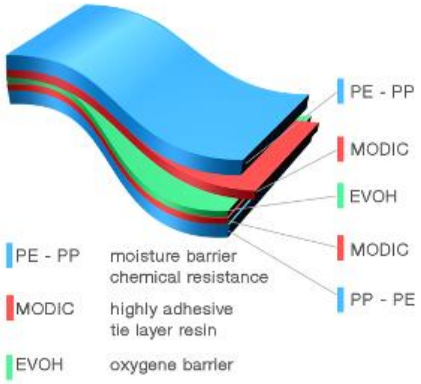


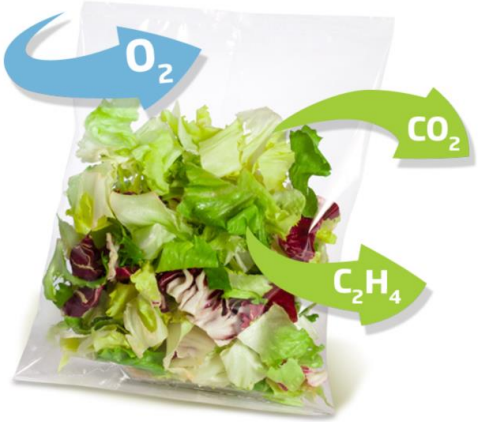
Packaging for Extending Produce Shelf Life

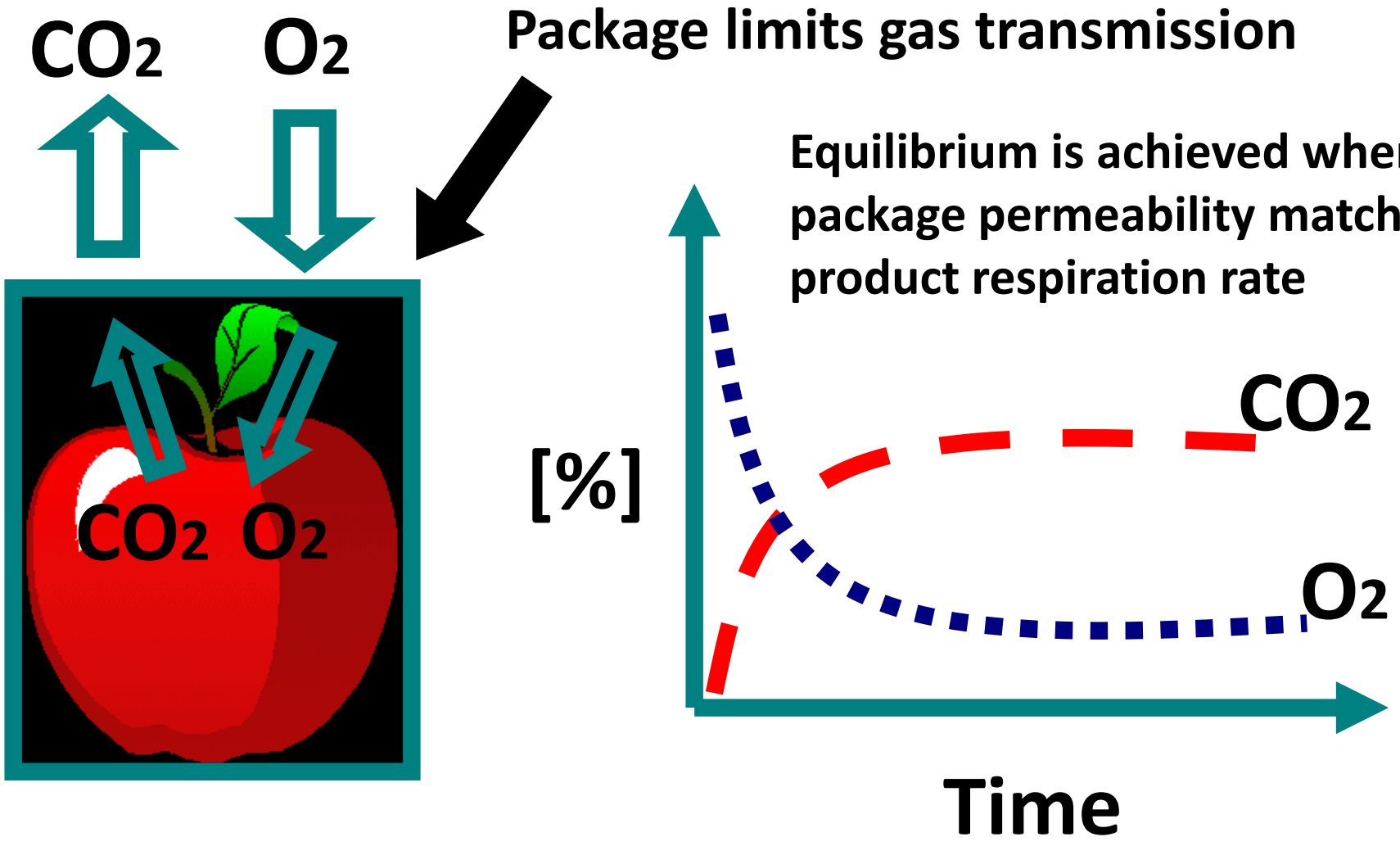
- Product deterioration rate is proportional to temperature ☛ cool the product and keep it cool
- Packaging supplements good postharvest temperature control
  - Protects the product from injury and contamination
  - Reduces water loss and product shrivel
- Modified Atmosphere Packaging (MAP) adds the benefits of reduced O_2 and elevated CO_2 in further slowing metabolic deterioration

Packaging for Extending Produce Shelf Life

- Modified Atmosphere Packaging (MAP)
  - Semipermeable plastic films and laminates with designed transmission of O_2 and CO_2 to match product respiration rates and create a desirable steady state atmosphere
  - Also have designed H_2O transmission properties
  - Used for the most perishable fruits & vegetables, including virtually all fresh-cut products






CO2
O2
Package limits gas transmission
Equilibrium is achieved when package permeability matches product respiration rate
CO2 O2
[%]
CO2
O2
Time

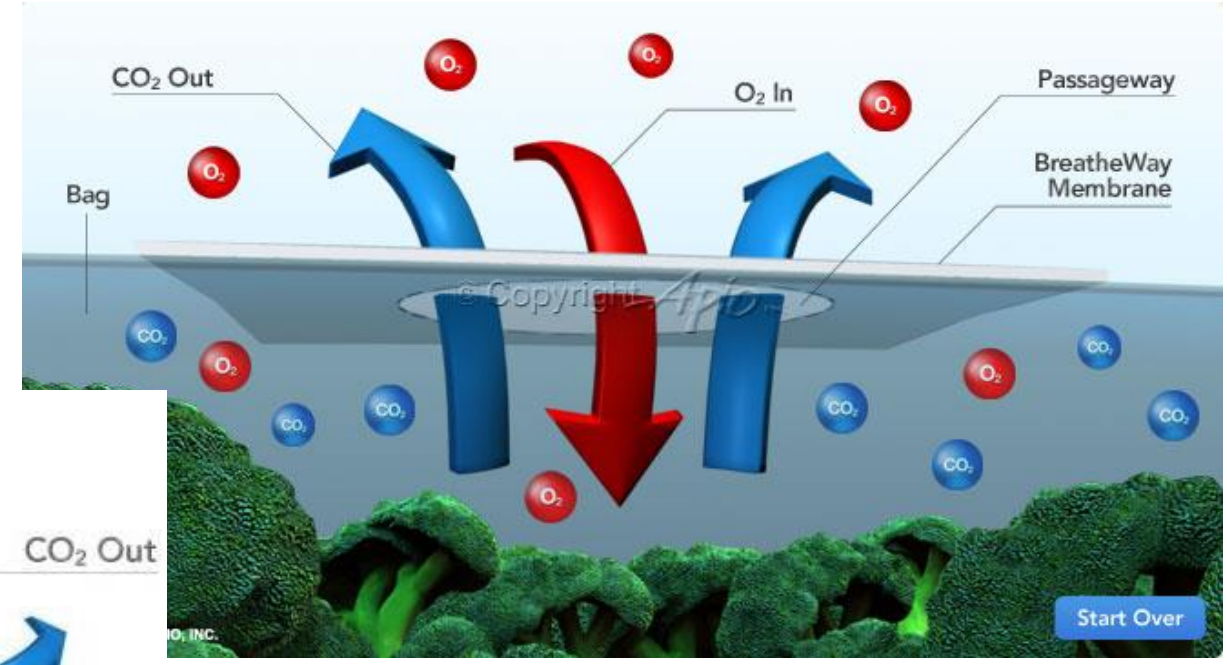
Temperature and MAP

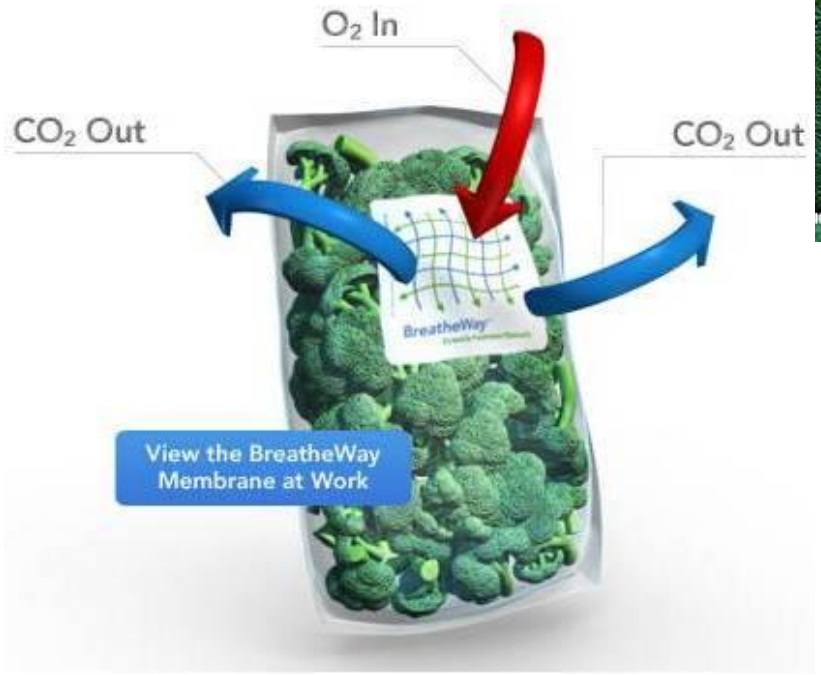
- Respiration rate *versus* temperature:
  - Fruits and vegetables: Q_{10} = 2 to 4
- Film permeability *versus* temperature:
  - Q_{10} = 1.2 to 1.3 for films
  - Q_{10} = 1 for perforations

Temperature and MAP

- That means produce respiration rate changes much more with temperature than does the film permeability
- Thus, a MAP cannot maintain beneficial atmospheres when products are exposed to temperatures outside the design parameters
  - For example, (lower) storage/trans-port temperatures *versus* (higher) retail display temperatures

Apio Breatheway® Temperature Responsive MAP System





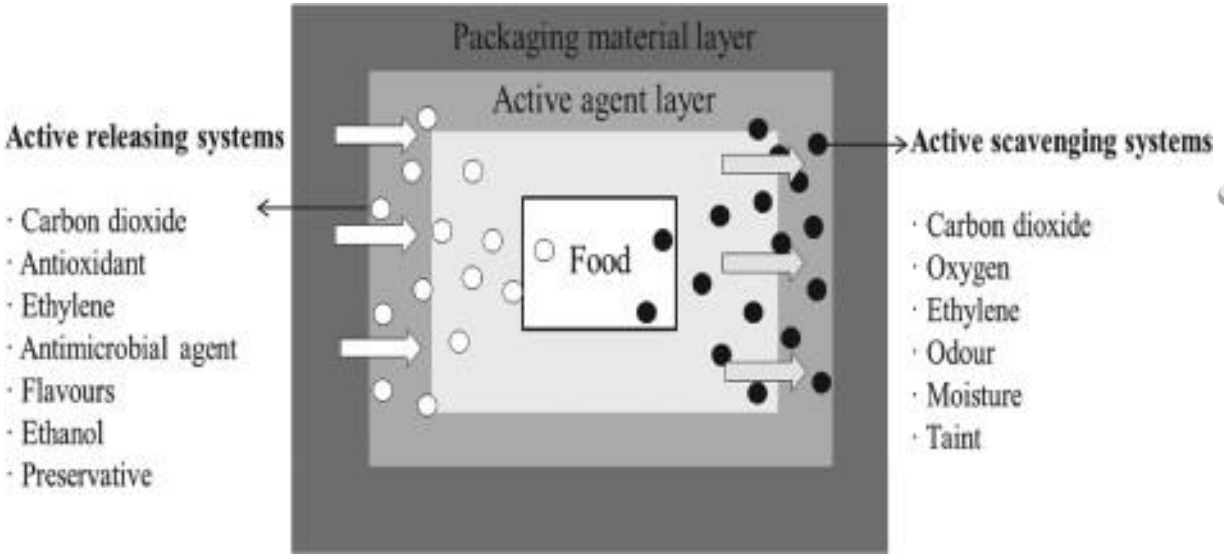
A hole is covered by a microporous patch that is coated with a polymer mixture.

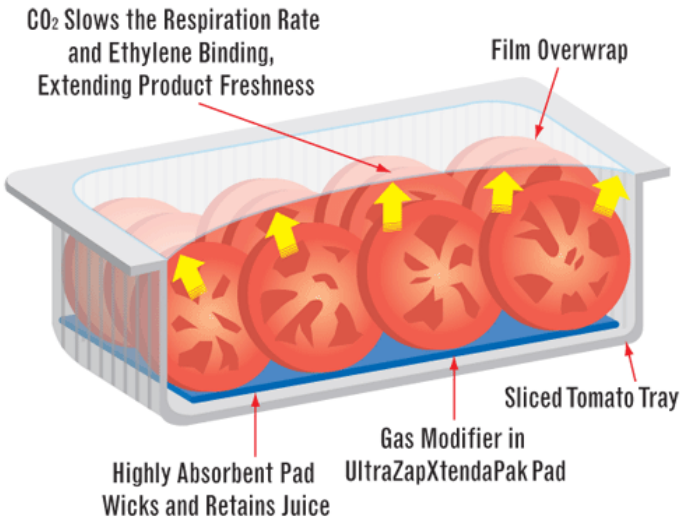
The polymer changes phase (solid-to- liquid) at a chosen temperature.

- The gas transmission rate increases significantly when the temperature exceeds the polymer melting point

Active/Smart MAP

- Two design approaches:
  - Packages containing sachets or pads (release/absorb)
  - Active compounds incorporated into or onto the packaging materials





Lee et al., 2015. JSFA 95:2799-2810

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MAP Package Requirements

Marketing

- Gloss
- Clarity vs. Haze
- Stiffness
- Antifog (*i.e.*, water condensation)
- Puncture resistance
- Flex crack resistance
- Color printing

Production

- Machine set-up
  - Seal temperature
  - Coefficient of Friction (CoF)

Machine-ability

- Hot tack
- Seal integrity

Thank You!