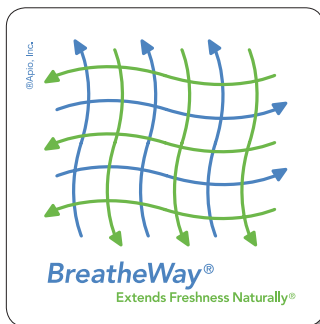


BreatheWay® MEMBRANE TECHNOLOGY

Intelligent modified atmosphere packaging

BreatheWay modified atmosphere technology

exponentially broadens the variety of packaging configurations and materials that can be used in combination with fresh products. Traditionally the choice of materials used for packaging fresh produce has been limited by permeability property considerations. With BreatheWay, manufacturers can choose packaging materials that offer more convenient machineability and still achieve the correct atmosphere for the extended shelf life of their products.

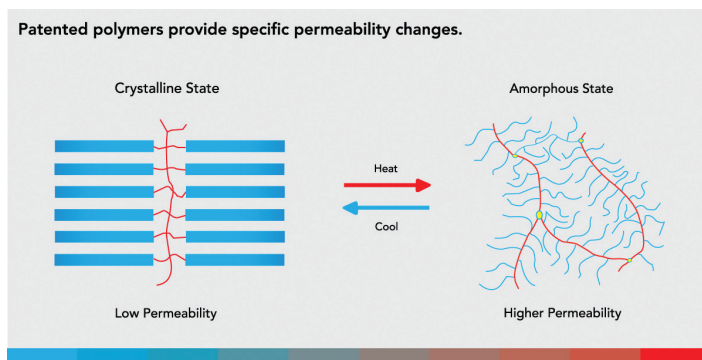


BreatheWay technology itself is a relatively small white membrane

with a pressure sensitive adhesive that is typically supplied on rolls or, in some cases, is provided on pre-made bags/containers depending on the customer's requirements. This membrane is placed over an open section of the package and provides all of the required gas exchange from this location.

Applications for BreatheWay technology

encompass a wide range of package sizes and products. From smaller consumer-sized packages for retail applications to case liners and pallet configurations for most fruits, vegetables and some horticultural products.



Modified atmosphere in general

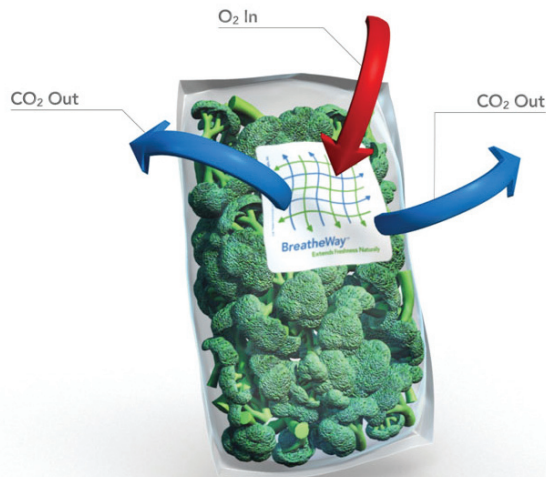
refers to the creation of an atmosphere in an enclosed space that differs from that of open atmosphere, (20.95% oxygen, 0.03% carbon dioxide and 78.09% nitrogen.). Therefore the term MAP (modified atmosphere packaging) is used for a wide variety of packaging solutions which include micro perforations and gas flushing. While other package systems often can modify package atmospheres moisture, they have no flexibility to adjust with temperature changes. BreatheWay membranes have a temperature response of 1.8 from 0-10 degrees C, which is close to the increase in respiration rate for produce over the same interval – thus allowing the package to adjust in permeability and help maintain the atmospheric requirements. In the event of temperature fluctuations this will decrease product stress, increase relative shelf life and reduce potential low oxygen food safety concerns.

BreatheWay technology preserves freshness,

extends shelf life, reduces dehydration and can compensate for mild temperature fluctuations in the storage and distribution chain. Because BreatheWay uses the natural respiration of the fresh fruits and vegetables to create their own specific extended shelf life environment, this package solution requires no additional gas flush or additional chemicals.

Unlike micro perforated films,

BreatheWay can selectively control both oxygen and carbon dioxide permeabilities. This opens a wide range of possible target package atmospheres to the package designer.



Landec is Apio's parent company

as well as the inventor and supplier of the patented polymer technology that provides the unique ratios and temperature switch properties of the BreatheWay membrane. A variety of polymer designs are used but each utilizes a proprietary side chain crystallized composition that offers tremendous flexibility when seeking to create highly specific atmospheres at a variety of temperatures and package sizes.

The UC Davis Postharvest website

(<http://postharvest.ucdavis.edu>) lists the recommended atmospheres for preserving fresh produce, the temperature of storage and the respiration rate associated. Using these data and a body of industry experience it is possible to calculate the correct BreatheWay technology configuration, using the appropriate membrane CO₂TR/OTR permeability ratio, which will allow the produce to develop the recommended equilibrium atmosphere.

TABLE 1 Permeabilities of SCC Coated Membrane, (SZ 100), and Polyethylene at 22°C				
Material	Permeability to O ₂	Permeability to CO ₂	Permeability to ethylene	Permeability to water
	(cc/100 sq.ins.atm-24hrs)	(cc/100 sq.ins.atm-24hrs)	(cc/100 sq.ins.atm-24hrs)	G/m ² *24hrs
Coated membrane (273-145)	280,000	1,120,000	1,080,000	849
Polyethylene film (2mils)	254	1,102	508	16

TABLE 2 Temperature Response, (P10), of SCC Coated Membrane, (SZ 100) Polyethylene and a Pinhole.	
Material	P10
	P10=Permeability at 10°C/Permeability at 0°C
Coated membrane	1.8
Polyethylene film (2mils)	1.4
Pinhole	1.06

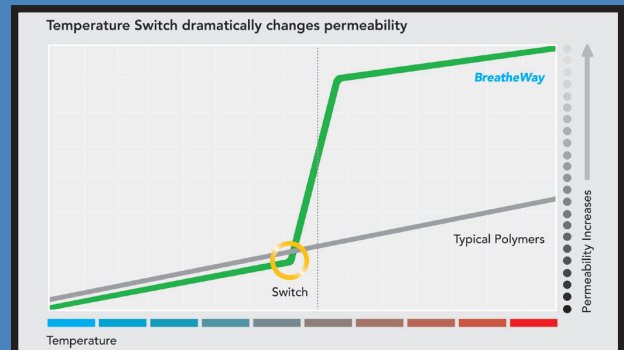


TABLE 3 Change in respiration rate of selected fruit and vegetables resulting from a 10°C increase in temperature in air and 3% O ₂ atmosphere.			
Commodity	Temperature Range (C)	Air	3% O ₂
Strawberry	0-10	3.01	2.78
Raspberry	0-10	2.88	2.51
Apple	0-10	2.78	-
Cauliflower	0-10	2.44	2.14
Brussel sprout	0-10	2.4	2.3
Broccoli	0-10	2.39	1.86
Cabbage	0-10	2.33	2.24
Celery	0-10	2.29	2.15
Lettuce	0-10	2.22	1.88
Asparagus*	0-10	2.22	1.77
Cherry*	1-15	2.9	-
Artichoke*	1-15	2.25	-
Cantaloupe*	5-21	2.85	-
Green Pepper	8-18	2.12	1.39
Tomato*	13-25	2.7	2.1

Ref Exema, Arul, Lencki, Lee and Toupin Journal of Food Science, Vol 58 No 6, 1993 p1365
*Ref Dr. J. Arul, personal communication, 10/2008