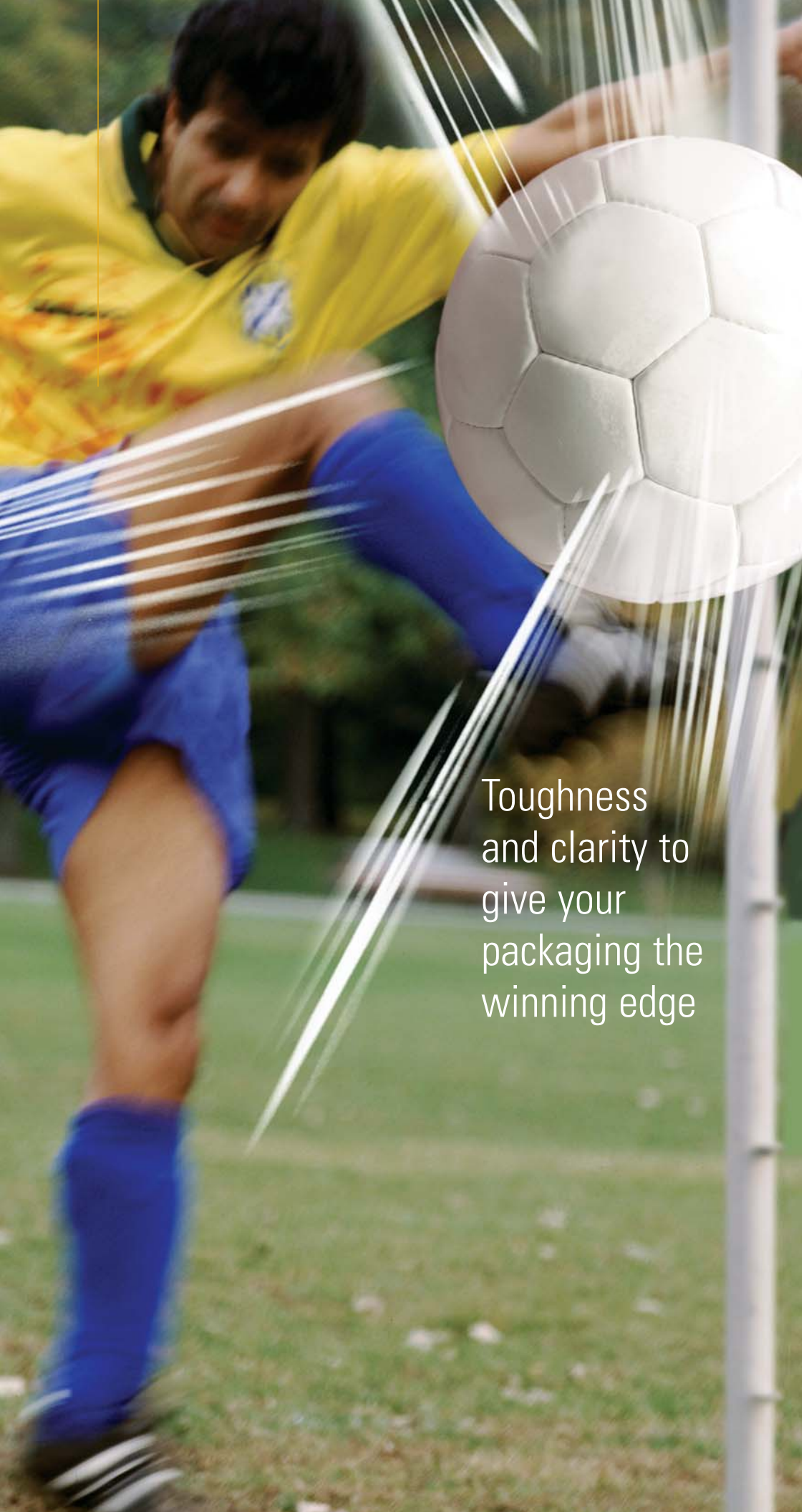


DOW®

ATTANE™ ULDPE Copolymers

Plastics – North America

ATTANE™ ULDPE and Dow: The team prepared to meet your packaging needs

As a key part of Dow's broad line of high-performance resins, ATTANE™ Ultra Low Density Polyethylene (ULDPE) copolymers offer you the added benefits of dealing with a leader in the global plastics market. World-class manufacturing, sales, and technical support facilities enable Dow to deliver high-quality, consistent polyethylene products and exceptional customer service virtually anywhere in the world.

Comparing products

Table 1 identifies the ATTANE™ ULDPE products and other resins that were tested for purposes of comparison. As you review the data contained in this brochure, please keep the following basics in mind:

- In comparison to the other polymers tested, ATTANE ULDPE copolymers provide significant improvements in toughness and overall performance.
- As the vinyl acetate content of EVA increases, so does the cost.

Toughness

Impact, tear, and puncture resistance

How tough are ATTANE™ ULDPE resins? Tough enough to provide significant increases in Dart Impact, Elmendorf Tear, and Puncture Force versus most competitive materials. This is illustrated by Figures 1 through 3, which show substantial performance improvements in comparison to 9-12% EVA and LLDPE resins, and comparable to moderate performance improvements versus EPE and POP resins.

Table 1: Food and Specialty Packaging Resins Tested [1]

Resin	Melt Index, g/10 min	Density, g/cc	Comonomer Wt.
ATTANE™ 4201G [2]	1.0	0.912	Octene
ATTANE™ 4203 [3]	0.8	0.905	Octene
AFFINITY™ PL 1840G	1.0	0.909	Octene
ELITE™ 5400G [4]	1.0	0.916	Octene
DOWLEX™ 2045G [5]	1.0	0.920	Octene
EVA	2.0	0.930	VA, 9%
EVA	0.35	0.930	VA, 12%

(1) Typical values, not to be construed as specifications.

(2) Commercially available ULDPE copolymer; satisfies requirements of U.S. FDA FCN 424.

(3) Commercially available ULDPE copolymer; satisfies requirements of U.S. FDA FCN 424.

(4) Commercially available EPE resin satisfies requirements of U.S. FDA 21 CFR 177.1520 (c) 3.2a.

(5) Industry "standard" LLDPE film resin; conventional density.

Unless otherwise noted, testing was conducted using either Dow test methods or the applicable ASTM standards. All monolayer films tested were fabricated to a nominal 0.002 in (2.0 mil) gauge using a 2.5:1 blow-up ratio. Coextruded films were 0.001 in (1.0 mil) overall, and had layer ratios of 15%/70%/15%.

Figure 1: Dart Impact [1]

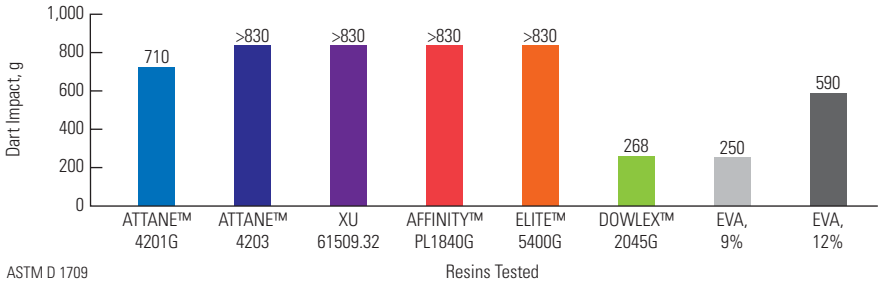


Figure 2: Elmendorf Tear [1]

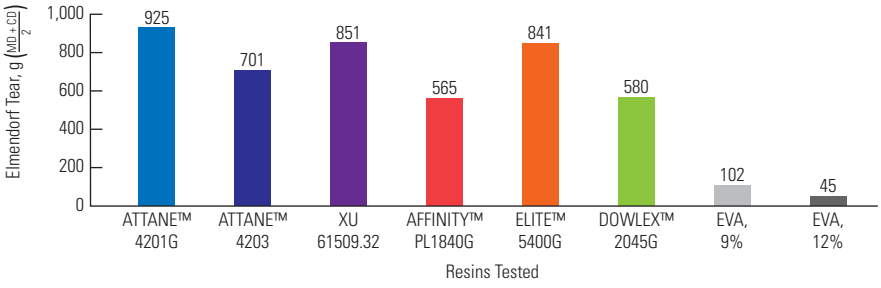
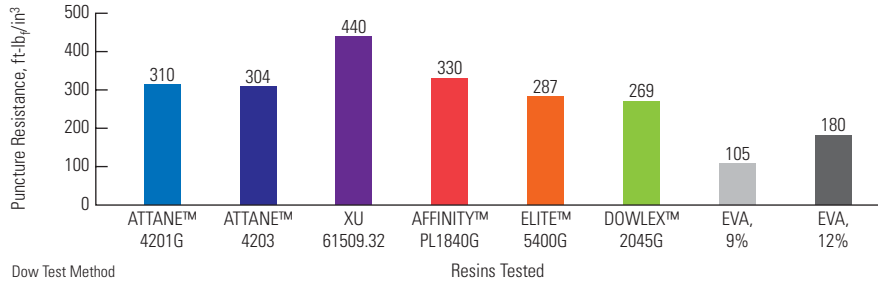


Figure 3: Puncture Resistance [1, 2]



[1] Typical values, not to be construed as specifications.

[2] Determined using an Instron tensile tester with a 0.5 in roundend probe at 10 in/minute of travel.

ATTANE™ copolymers (especially ATTANE 4203) also retain superior toughness at low temperatures, as illustrated in Figures 4 and 5.

Low modulus, density, and crystallinity

The excellent energy-absorbing abilities illustrated in Figures 1 through 3 are also related to low modulus. In addition to low modulus, the low crystallinity of ATTANE™ copolymers contributes to an improvement in the "cling" of stretch cling films.

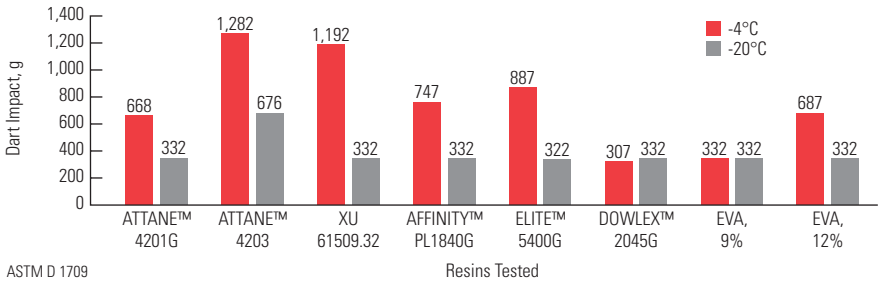
2% secant modulus

The "softness" of a resin is strongly related to low relative 2% secant modulus. As illustrated in Figure 6, the 2% secant modulus values of ATTANE™ ULDPE copolymers are comparable to those of most resins tested, and much lower than EPEs. This characteristic also contributes to the excellent low temperature performance of ATTANE resins in flexible packaging, and makes packages better able to withstand handling.

Flexural properties

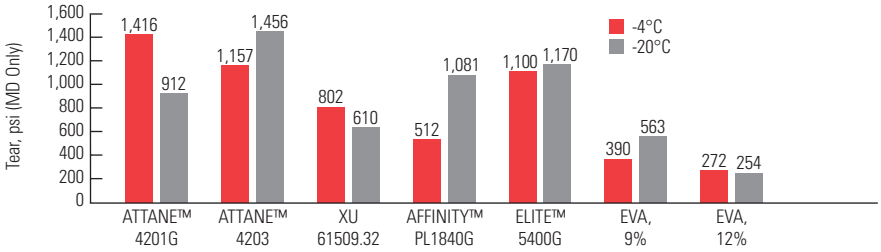
The high tensile strength and low crystallinity of ATTANE™ ULDPE resins relate directly to longer flexural life – which can help predict a resin's performance in flexible packaging applications. Table 2 illustrates that ATTANE copolymers offer nearly double the flexural performance of DOWLEX™ Polyethylene Resin and even greater improvements versus 9-12% EVAs.

Figure 4: Cold Temperature Dart Impact [1]



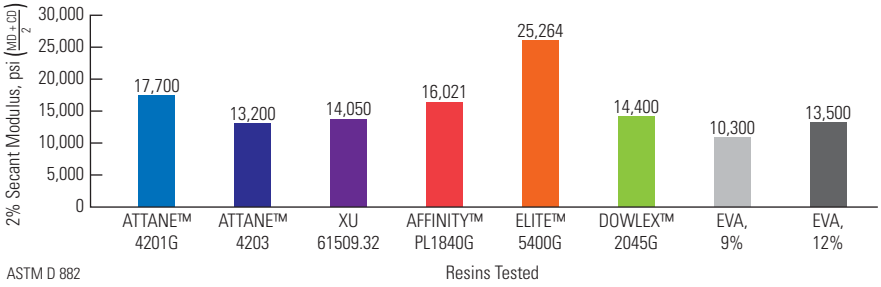
ASTM D 1709

Figure 5: Cold Temperature Tear [1]



ASTM D 1922

Figure 6: 2% Secant Modulus [1]



ASTM D 882

Table 2: Flexural Performance (-40°C) (1)

Resin	Resin Flexes to Failure (2)
ATTANE™ 4201G	> 7,500,000
ATTANE™ 4203	> 7,500,000
DOWLEX™ 2045G	3,800,000
12% EVA	600,000
9% EVA	145,000

(1) Typical values, not to be construed as specifications.

(2) Test Conditions: Typically, samples (0.05 in thick x 0.50 in wide x 9.25 in long) cut from molded plaques or extruded sheets are flexed in a controlled environment within a temperature range of ambient to -40°C. Both ends of the sample are clamped; one clamp is stationary, the other is moved via a reciprocating shaft which causes the sample to be flexed approximately 180° at 300 flexes per minute until sample failure. Failure is defined as either a visible crack across the specimen width, or a catastrophic break at any point between the ends of the specimen.

[1] Typical values, not to be construed as specifications.

[2] Topwave HT Tester, 0.5 sec dwell, 40 psi bar pressure, 10 in/min (254 mm/sec) pull speed.

Optics

Clarity, haze, and 45° gloss

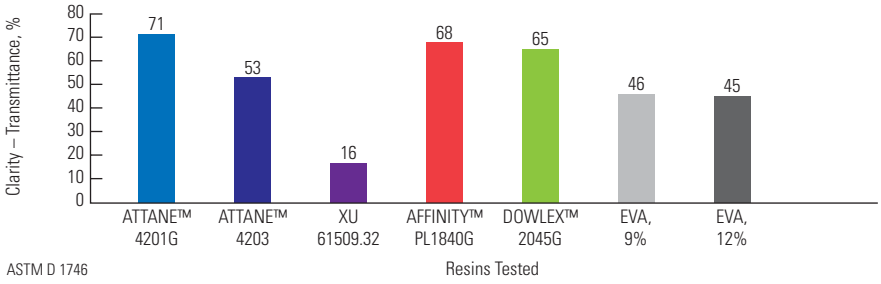
Optical properties such as clarity, haze, and 45° gloss are extremely important to the visual presentation of many applications. If the end-use customer can't see the product – or the packaging material selected makes the product look less appealing – the sale may be lost. As illustrated in Figures 7 through 9, ATTANE™ ULDPE copolymers offer comparable optical performance to most materials tested. When combined with excellent toughness and overall performance, these optical properties help make ATTANE resins an excellent choice for many applications.

Other properties

Vicat softening point

Figure 10 illustrates the Vicat Softening Points of the materials tested. The relatively low softening points of ATTANE™ ULDPE resins are significant because minimum sealing temperatures are also reduced, thus increasing the sealing window, or range.

Figure 7: Clarity[1]



ASTM D 1746

Figure 8: Haze[1]

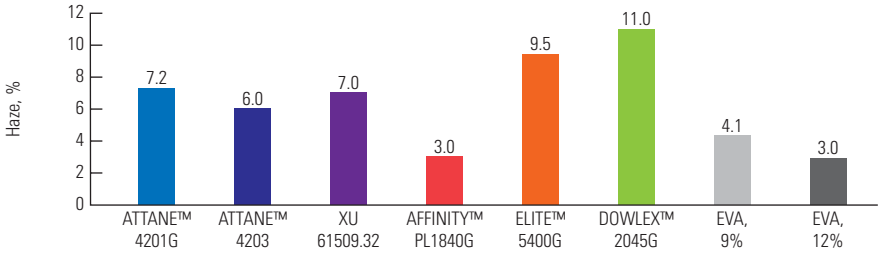


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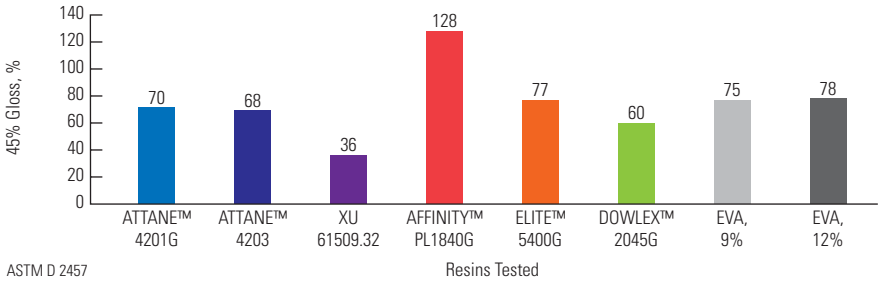
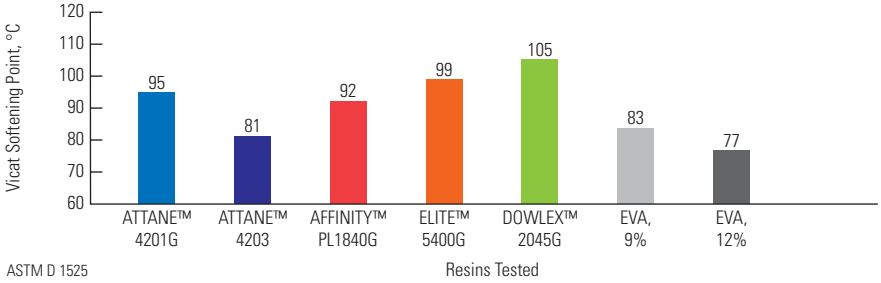
Figure 9: 45° Gloss[1]



ASTM D 2457

Figure 10: Vicat Softening Point[1]



ASTM D 1525

[1] Typical values, not to be construed as specifications.

Figure 11: Heat Seal Strength versus Temperature[1, 2]

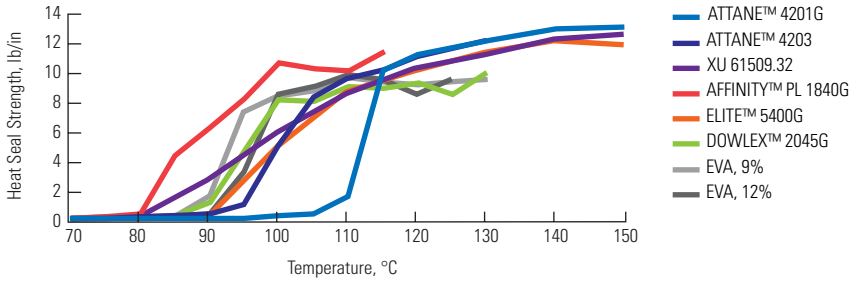
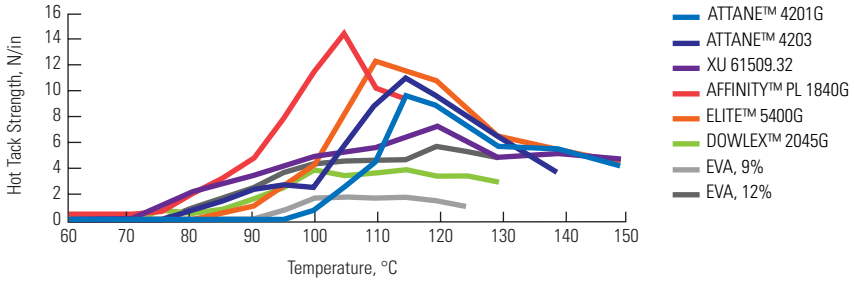


Figure 12: Hot Tack Strength versus Temperature[1, 2]



Heat seal, and hot tack strength

Figures 11 and 12 illustrate comparable or better heat seal and hot tack performance for ATTANE™ ULDPE copolymers versus EVA and DOWLEX™ resins.

Moisture vapor and oxygen transmission

The moisture and gas transmission properties of plastic films directly influence the quality, appearance, and shelf life of many packaged goods. Figure 13 illustrates that ATTANE™ ULDPE resins offer similar moisture vapor transmission rates to other Dow resins tested, and significant improvements versus 9-12% EVAs. Combined with relatively high oxygen transmission rates (Figure 14), this performance makes ATTANE resins an exceptional choice for many applications, including fresh-cut produce packaging.

Figure 13: Moisture Vapor Transmission Rate (MVTR)[1, 2]

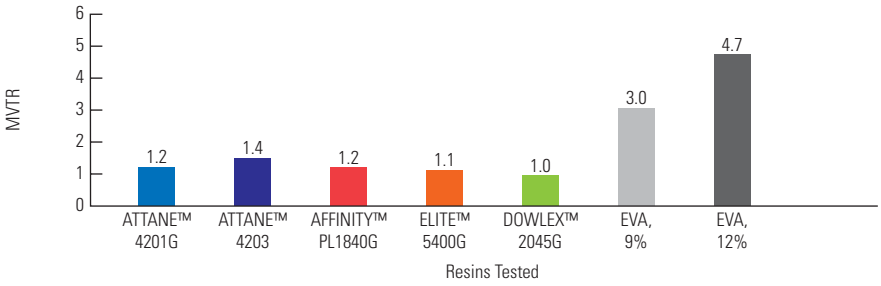


Figure 14: Oxygen Transmission Rate (OTR)[1]

ASTM D 3985-81

[1] Typical values, not to be construed as specifications.

[2] Data acquired using Mocon Permatron W-1 equipment; Mocon Test Method.

Off-taste and odor

ATTANE™ ULDPE copolymers also offer minimal taste and odor contributions versus EVAs, where acetic acid and residual vinyl monomer can cause taste/odor problems.

Gamma sterilization

The packaging of medical devices and other specialized applications often requires the use of radiation for sterilization purposes. Resins such as EVA and PP tend to experience chain scission (breaking apart of molecules) and property deterioration when exposed to ionizing radiation. In contrast, ATTANE™ ULDPE and DOWLEX™ resins can accept relatively high levels of radiation with little or no adverse effect on property performance.

FDA status

When used unmodified and in accordance with good manufacturing practices for food contact applications, ATTANE™ ULDPE copolymers comply with the Federal Food, Drug, and Cosmetic Act as a food contact substance as a result of a premarket food contact notification (FCN) with an effective date of October 7, 2004, under FCN 424. This notification allows for use of this product as articles or components of articles used in contact with all food types under Conditions of Use A through H, as described in Table 3 below per U.S. FDA, 21CFR176.170(c).

Table 3: Conditions of Use from U.S. FDA, 21CFR176.170(c)

Condition of Use	Description
A	High temperature heat-sterilized (e.g., over 212°F)
B	Boiling water sterilized.
C	Hot filled or pasteurized above 150°F
D	Hot filled or pasteurized below 150°F
E	Room temperature filled and stored (no thermal treatment in the container).
F	Refrigerated storage (no thermal treatment in the container)
G	Frozen storage (no thermal treatment in the container)
H	Frozen or refrigerated storage: Ready-prepared foods intended to be reheated in container at time of use.

All-star versatility

Their rugged versatility makes ATTANE™ ULDPE copolymers well suited for blown and cast film applications, as well as extrusion processes. In fact, the exceptional toughness of these products makes them an excellent choice for the downgauging of coextruded films. ATTANE resins typically can be processed on existing equipment, particularly those machines designed to process LLDPE resins. The non-polarity of these ULDPE resins provides better chemical resistance and thermal stability in processing than polar copolymers such as EVAs.

Give ATTANE™ ULDPE a tryout.

With their unique combination of rugged protection and excellent optics – plus their other performance attributes – ATTANE™ ULDPE copolymers could give you the winning edge and offer you the opportunity to maximize the profitability of your toughest applications.

To try ATTANE copolymers in your processing equipment or receive additional information, contact your Dow sales representative.

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b. use in cardiac prosthetic devices regardless of the length of time involved; (Cardiac prosthetic devices include, but are not limited to, pacemaker leads and devices, artificial hearts, heart valves, intra-aortic balloons and control systems, and ventricular bypass assisted devices);
c. use as a critical component in medical devices that support or sustain human life; or
d. use specifically by pregnant women or in applications designed specifically to promote or interfere with human reproduction.

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