imagine a healthy, beautiful smile

oral care product guide
At Ashland, we are committed to creating innovative ingredient technologies that improve the efficacy, usability and consumer appeal of oral care products. Toothpaste, mouthwash, and denture adhesives are just a few of the oral care products that benefit from the use of our ingredients. Today, Ashland’s broad oral care ingredient portfolio includes bioadhesive polymers, teeth bleaching agents, stain removers, rheology modifiers, mouth moisturizers, and custom encapsulates.

Ashland solvers are focused on innovation and continue to see and understand the market activity and emerging trends around the world. In pursuit of new solutions, we bring all of the technical disciplines together, including molecular (synthesis) science, analytical, microbiology research, materials science, encapsulation technology, consumer evaluation and application/formulation development. New materials, tailor-made and custom grades are routinely evaluated by our global network of application and formulation scientists to solve technical challenges and delight consumers.

Our success depends on your success and we stand ready to solve with you at every step from innovative ingredients to technical service and awareness of market trends. We do more than just manufacture innovative ingredients to demanding quality standards; our products are supported by dedicated oral care solvers. We are committed to helping you grow.

Get to know us and you’ll see how Ashland keeps the world smiling.

Ashland works to understand the properties of our ingredients and their performance in oral care formulations. With our global network of oral care laboratories staffed with experienced scientists, we routinely conduct in vitro performance evaluations of toothpaste, mouth rinse and denture adhesive formulations. We support all our ingredient solutions with formulation expertise and robust testing resources, including:

- assessment of actives delivery and retention to teeth and mucous membranes
- characterization of polymer effects on prevention of enamel demineralization from dietary acids
- measurement of rheology and complex flow behavior using advanced techniques
- formulation of laboratory-scale toothpaste batches and stability testing
- evaluation of teeth cleaning/stain removal, stain prevention or whitening by instrumental color measurement
- evaluation and formulation of teeth whiteners
- assessment of toothpaste using V-8 brushing machine and mouth wash on bovine enamel and artificial teeth
- in vitro evaluation of denture adhesive formulations performance as well as extensive formulation knowledge
- consumer panel testing of toothpaste and mouthwash formulations

We can help solve difficult formulating challenges and bring new formulations to market faster. Ashland will work with you to find new and better ways to deliver oral health and create beautiful smiles.

Our global capabilities include:

- technical service scientists to help formulators bring new and improved formulations quickly to consumers
- oral care in vitro evaluation of ingredients and formulations to provide new and improved end-product benefits
- technical leadership in science of rheology and bioadhesion
- innovative starter formulations and new market concepts
- demonstration of consumer-perceivable benefits using consumer panels
- synthesis of new polymers and evaluation using advanced analytical and material science methods for understanding of structure function relationship

Ashland always adding.
Ashland is a leading supplier of innovative ingredients that solve complex formulation challenges in toothpaste, mouthwash, denture adhesives, denture cleanser tablets, tooth whiteners and mouth moisturizers.

**solutions for high performance denture adhesives**

For denture wearers, adhesives that hold dentures in place throughout the day are critical. Our polymers give the duration and strength of hold expected of modern denture adhesives creams, powders and pads. Aqualon™ and Blanose™ carboxymethylcellulose (CMC) gives initial tack to denture adhesives while Gantrez™ AN polymer salts such as MS-955 provide duration of hold in denture adhesives.

**solutions for delivery and retention of actives**

Delivering and retaining actives in the mouth are key for improving efficacy of toothpaste and mouthwashes. The combination of Gantrez™ S-97 polymer with a surfactant greatly enhances the buccal retention of active materials that are water insoluble and emulsifiable by the surfactant such as antimicrobial agents and flavors to provide long-lasting benefits.

**solutions for whiter teeth**

With consumers around the world wanting whiter and brighter teeth, Ashland offers Plasdone™ K-29/32 polymer to gently and effectively lift staining agents during brushing or rinsing, leaving teeth measurably whiter. For teeth bleaching, Peroxydone™ complexes are very stable, powder complexes of hydrogen peroxide and polymers that release hydrogen peroxide on contact with saliva in the mouth. These novel polymers can be formulated into a wide range of product forms including liquids, gels, tablets, strips and films for whiter teeth.

**solutions to modify and control rheology**

Ashland offers the widest range of cellulose ether and synthetic polymers to modify and control rheology. Ashland’s cotton- and wood-derived cellulose ethers offer formulators a wide range of nature-based options for thickening, rheological modification, and film formation, with a natural origin content of up to 80%.[1] As toothpaste formulations have become diversified, driven by new actives and need for increasing performance, we have responded with tailor made grades and types of rheology modifiers to meet the needs of specific applications.

**Nature-Derived Origin Content**

- **Aqualon™ and Blanose™ sodium carboxymethylcellulose**
- **Benecel™ hydroxypropylmethylcellulose**
- **Klucel™ hydroxypropylcellulose**
- **Natrosol™ hydrosylcellulose**
- **Polyplasdone™ polymers**
- **Captivates™ IC encapsulates**
- **Captivates™ IC encapsulates**
- **Hydrogels**
- **Lubrajel™ SX hydrogel**
- **Allantoin**

*Allantoin is a registered trademark of United-Guardian, Inc. † Naturality is grade dependent based on capsule inner phase.

**solutions for mouth lubrication and moisturization**

With the increasing use of medications around the world, a growing number of consumers seek artificial saliva or mouth moisturizing gels, sprays and rinses to address dry mouth. Mouth moisturizer formulations are designed to have the flow and lubricity similar to natural saliva as well as high mucoadhesion to stay in the mouth between applications.
an introduction to Ashland oral care ingredient portfolio

polymers: synthetic

gantrez™ AN polymers
Gantrez™ polymers are a family of synthetic copolymers based on methyl vinyl ether (MVE) and maleic anhydride that offer excellent bioadhesive properties. The anhydride powders (AN grades) are the base polymer for making polymer salts used as bioadhesives in denture adhesive applications. The AN grades are available in a range of molecular weights, but are not used directly in oral care applications.

<table>
<thead>
<tr>
<th>grade</th>
<th>structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>AN-169</td>
<td><img src="AN-169.png" alt="Structure" /></td>
</tr>
</tbody>
</table>

Gantrez™ S polymers
INCI Name: PVM/MA copolymer
Gantrez™ S polymers are the free acid form of copolymers of MVE and maleic anhydride utilized for their excellent film-forming properties; highly-effective chelation and exceptional bioadhesive performances in wet environments. Gantrez™ S polymers are available in a range of molecular weights.

toothpastes and mouthwashes
Gantrez™ S polymers are an excellent mucosal adhesive for delivery and retention of antimicrobial agents, colors and flavors. In addition, Gantrez™ S polymers impart tartar control and dentin tubule flow reduction. Gantrez™ S polymers are available as aqueous solutions and/or powder, depending on the grade.

denture cleansers
In denture cleansers, Gantrez™ S polymers provide active and flavor delivery.

<table>
<thead>
<tr>
<th>grade</th>
<th>structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-97</td>
<td><img src="S-97.png" alt="Structure" /></td>
</tr>
<tr>
<td>S-96</td>
<td><img src="S-96.png" alt="Structure" /></td>
</tr>
</tbody>
</table>

gantrez™ MS-955 polymer
INCI Name: calcium/sodium PVM/MA copolymer
Gantrez™ MS-955 polymer is a mixed sodium and calcium salt of MVE and maleic anhydride copolymer supplied as an off-white powder. The polymer is slowly soluble in water, resulting in amber-colored solutions with high viscosity and adhesion.

denture adhesives
Gantrez™ MS-955 polymer delivers the long-term hold expected of modern denture adhesives. It is used in denture adhesive formulations with Aquauron™ or Blanose™ CMC.

<table>
<thead>
<tr>
<th>grade</th>
<th>structure</th>
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</thead>
<tbody>
<tr>
<td>MS-955</td>
<td><img src="MS-955.png" alt="Structure" /></td>
</tr>
</tbody>
</table>

plasdone™ and flexithix™ polymers
INCI Name: PVP
Plasdone™ polymers are pharmaceutical-grade homopolymers of N-vinyl-2-pyrolidone (NVP) supplied as white, free flowing powders. Available in a range of molecular weights, they are characterized by K-value. PVP polymers are soluble in water, highly adhesive and form glossy, transparent, oxygen permeable films. Flexithix™ polymer is a novel polymer based on PVP.

toothpastes and mouthwashes
Plasdone™ K-29/32 polymer delivers non-abrasive and non-oxidative teeth whitening for brighter, whiter smiles. Plasdone™ K-29/32 polymer will form complexes with many of the chemicals that cause teeth stains resulting in a water-soluble complex that is easily removed during rinsing. Flexithix™ polymer is a rheology modifier for thickening challenging formulations. It is a good choice for anhydrous toothpaste formulations.

denture cleansers
Plasdone™ polymers are highly effective tablet binders for denture cleanser tablets.

<table>
<thead>
<tr>
<th>grade</th>
<th>structure</th>
<th>molecular weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-29/32</td>
<td><img src="K-29/32.png" alt="Structure" /></td>
<td>58,000</td>
</tr>
<tr>
<td>K-90</td>
<td><img src="K-90.png" alt="Structure" /></td>
<td>1,300,000</td>
</tr>
</tbody>
</table>

Flexithix™ polymers
key benefits:
- provides improved toothpaste structure and bead stand-up with less stringiness
- improves formulation robustness over acrylate thickeners alone

plasdone™ polymers
key benefits:
- complexes with common staining agents to whiten teeth
- reduces in vitro teeth staining from cationic antibacterial and stannous compounds
- acts as a tablet binder resulting in tablets with high breaking force and low friability
- modifies solution viscosity
- forms water-soluble films
- adds lubricity
plasdone™ S-630 polymer
INCI Name: VP/VA copolymer
Plasdone™ S-630 polymer is a pharmaceutical-grade 60:40 linear, random copolymer of NVP and vinyl acetate. The addition of vinyl acetate to the vinylpyrrolidone polymer chain reduces hydrophilicity and glass transition temperature (Tg) of the copolymer relative to PVP. As a result, Plasdone™ S-630 polymer is an excellent adhesive material and a tougher, more flexible film former than PVP.

denture cleansers
Plasdone™ S-630 polymer is a highly effective tablet binder for denture cleanser tablets. Because of their large size and high inorganic content, denture cleanser tablets need a highly adhesive tablet binder to increase tablet breaking force and reduce friability. In addition, the binder should be water soluble so that the consumer experiences, a clear, haze-free solution, upon tablet dissolution. Plasdone™ S-630 polymer delivers the performance required.

Technical grades are also available. Technical molecular weight (SEC/MLA/MALLS)

<table>
<thead>
<tr>
<th>grade</th>
<th>structure</th>
<th>typical weight average molecular weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-630</td>
<td><img src="image" alt="structure" /></td>
<td>47,000</td>
</tr>
</tbody>
</table>

polyplasdone™ polymers
INCI Name: PVP
Polyplasdone™ polymers are insoluble, crosslinked homopolymers of NVP that differ by particle size. The nonionic polymer swells on contact with water.

toothpastes
With the increasing number of active ingredients that are not compatible with water, there is a growing need for thickeners for anhydrous systems. Polyplasdone™ polymers: cellulose ethers

key benefits:
- acts as a tablet binder resulting in tablets with high breaking force and low friability
- forms tough, clear, flexible films with high substantivity to skin

in denture adhesives
In denture adhesive powders and creams, CMC provides the initial wet tack necessary for holding dentures in place.

polyplasdone™ polymers
INCI Name: PVP
Polyplasdone™ polymers are insoluble, crosslinked homopolymers of NVP that differ by particle size. The nonionic polymer swells on contact with water.

Aqualon™ and Blanose™ sodium carboxymethylcellulose (CMC)
INCI Name: cellulose gum
Aqualon™ and Blanose™ CMC are anionic, water-soluble cellulose ethers, produced by reacting alkali cellulose with monochloroacetic acid under controlled conditions. A variety of grades with different degrees of substitution (DS), viscosities and particle sizes to meet specific formulation requirements are available. Based on the local regulatory requirements of the final product formulation, grades that comply to food and pharmaceutical requirements are offered. Ashland provides CMC under the tradenames Aqualon™ CMC and Blanose™ CMC depending on site of manufacture.

toothpastes
CMC is used to modify rheology, bind water for the prevention of syneresis and impart desirable flow properties to the formulation. CMC provides excellent rheology properties such as shear thinning for ease of filling tubes and dispensing onto brush as well as excellent stand-up; clean ribbon cut-off and smooth non-stringsy appearance.

Selecting the CMC grade for your formulation will depend on the desired properties of the toothpaste formulation. Many grades are available. In general, Aqualon™ or Blanose™ 9M31F or 9M31XF CMC are recommended.

denture adhesives
In denture adhesive powders and creams, CMC provides the initial wet tack necessary for holding dentures in place. To get started, Aqualon™ or Blanose™ 7H33XF CMC are suggested.

key benefits:
- acts as a thickener for aqueous systems
- provides shear-thinning rheology properties
- inhibits syneresis formation
- provides initial wet tack to denture adhesive
- “COSMOS” validated

![in-game](image)
**benecel™ HPMC**

**INCI Name:** Hydroxypropylmethylcellulose

Benecel™ HPMC is a high-purity, water-soluble, nonionic cellulose ether designed for use as a thickener, foam enhancer, foam stabilizer, waterbinder, film former, as well as a co-suspending and co-emulsifying agent.

- acts as highly efficient foam booster and stabilizer
- forms stable foam with high wall elasticity
- improves foam volume
- enhances the brushing experience by enhancing foam texture
- builds creamy and dense foam

**Grade**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Structure</th>
<th>Typical Brookfield viscosity (mPa.s) at 25°C</th>
<th>Approximate molecular weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>E4M</td>
<td><img src="image1.png" alt="E4M structure" /></td>
<td>2,700–5,040</td>
<td>150,000</td>
</tr>
</tbody>
</table>

**natrosol™ HEC**

**INCI Name:** Hydroxyethylcellulose

Natrosol™ HEC is a nonionic, water-soluble polymer, derivatized from cellulose. It is available in polyols and completely soluble in water. Natrosol™ HEC is available in a wide variety of molecular weights.

**key benefits:**
- offers excellent tolerance to mono-, di-, and tri-valent cations
- provides rheology properties such as shear-thinning for ease of filling tubes during manufacture and ease of dispensing onto brush
- impacts glossy, smooth ribbon appearance
- inhibits syneresis formation
- is nonionic resulting in compatibility with wide range of actives

**Grade**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Structure</th>
<th>Typical Brookfield viscosity (mPa.s) at 25°C</th>
<th>Approximate molecular weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>HH, HX</td>
<td><img src="image2.png" alt="HH, HX structure" /></td>
<td>3,500–5,500</td>
<td>1.3 x 10⁵</td>
</tr>
<tr>
<td>M</td>
<td><img src="image3.png" alt="M structure" /></td>
<td>1,500–2,500</td>
<td>1.0 x 10⁵</td>
</tr>
<tr>
<td>G</td>
<td><img src="image4.png" alt="G structure" /></td>
<td>4,500–6,500</td>
<td>7.2 x 10⁴</td>
</tr>
<tr>
<td>L</td>
<td><img src="image5.png" alt="L structure" /></td>
<td>150–400</td>
<td>3.0 x 10³</td>
</tr>
<tr>
<td>E</td>
<td><img src="image6.png" alt="E structure" /></td>
<td>7.5–150</td>
<td>9.0 x 10²</td>
</tr>
</tbody>
</table>

**klucel™ HPC**

**INCI Name:** Hydroxypropylcellulose

Klucel™ HPC is a nonionic, water-soluble cellulose ether with a remarkable combination of properties. It combines organic solvent solubility, thermoplasticity, and surface activity with the aqueous thickening and stabilizing properties characteristic of other water-soluble cellulose polymers. HPC films are flexible without plasticizers and non-tacky at high humidity.

**key benefits:**
- thickens anhydrous systems (all grades thicken propylene glycol and ethanol; low molecular weight L and E grades thickener propylene glycol)
- binds tablets

**Grade**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Structure</th>
<th>Typical Brookfield viscosity (mPa.s) at 25°C</th>
<th>Approximate molecular weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td><img src="image7.png" alt="H structure" /></td>
<td>1,500–3,000</td>
<td>115,000</td>
</tr>
<tr>
<td>M</td>
<td><img src="image8.png" alt="M structure" /></td>
<td>4,000–6,500</td>
<td>850,000</td>
</tr>
<tr>
<td>G</td>
<td><img src="image9.png" alt="G structure" /></td>
<td>150–400</td>
<td>370,000</td>
</tr>
<tr>
<td>J</td>
<td><img src="image10.png" alt="J structure" /></td>
<td>150–400</td>
<td>140,000</td>
</tr>
<tr>
<td>L</td>
<td><img src="image11.png" alt="L structure" /></td>
<td>75–150</td>
<td>95,000</td>
</tr>
<tr>
<td>E</td>
<td><img src="image12.png" alt="E structure" /></td>
<td>300–400</td>
<td>80,000</td>
</tr>
</tbody>
</table>

*In aqueous solution, RVT viscometer, 20 rpm.*
**polymer complexes**

**peroxydome™ complexes**

**INCI Name:** PVP (and) hydrogen peroxide

Peroxydome™ complexes are a family of stable, hydrogen-bonded complexes on vinyl Peroxydome™-based polymers with hydrogen peroxide. Peroxydome™ complexes are very stable, solid complexes that release hydrogen peroxide on contact with water or saliva in the mouth to provide oxidative teeth whitening. As Peroxydome™ complexes retain the properties of the base polymer, these unique complexes offer a range of solubility, substantivity, viscosity and film-forming benefits.

**teeth whiteners**

Consumers want whiter and brighter teeth, but not all stains can be brushed away. Bleaching products that penetrate into and oxidatively whiten teeth provide effective results and, therefore, are popular with consumers. Peroxydome complexes are the logical choice for delivery of hydrogen peroxide to teeth. They provide excellent substantivity, bioadhesion, film-forming and thickening with excellent formulation stability without odor or taste, unlike other solid forms of hydrogen peroxide. Peroxydome complexes can be formulated into a wide variety of product forms, including liquids, gels, tablets, strips and films.

<table>
<thead>
<tr>
<th>grade</th>
<th>base polymer</th>
<th>structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-50</td>
<td>PVP</td>
<td><img src="image" alt="Structure K-50" /></td>
</tr>
<tr>
<td>XL-10</td>
<td>Crosslinked PVP</td>
<td><img src="image" alt="Structure XL-10" /></td>
</tr>
</tbody>
</table>

**key benefits:**
- releases hydrogen peroxide for oxidative whitening
- are supplied as very stable powders
- act as excellent film formers, tablet binders or disintegrants
- provides a range of solubilities, substantivity and viscosities

**encapsulation technology**

**captivates™ HC encapsulates**

Captivates™ HC encapsulates series are small particles that contain an active ingredient, or core material, surrounded by a shell and are produced using a complex coacervation process. The shell materials are natural and nature-derived from tree-sap and food waste. During brushing when pressure is applied, the capsules break to release the core material. Capsule wall thickness, color, capsule size and core material can be customized to meet the desired properties of the applications. The capsule shells are biodegradeable.

**toothpastes and mouthwashes**

Captivates™ HC encapsulates enable the opportunity to create unique sensory experiences that appeal to consumers. Visible capsules have a minimum diameter of 500 microns to provide striking visual impact while delivering core materials. Encapsulates are non-identifiable to the naked eye in the 15 to 50 micron range. HC encapsulates are custom formulated; however, several standard starting point grades are available. The typical use level is 0.5-2.0%.

<table>
<thead>
<tr>
<th>grade</th>
<th>function</th>
<th>appearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>HC0004</td>
<td>provides peppermint flavor burst</td>
<td>silver capsule</td>
</tr>
<tr>
<td>HC5605</td>
<td>releases a cooling flavor with hints of gentle warming</td>
<td>blue capsule</td>
</tr>
<tr>
<td>HC5773</td>
<td>delivers malodor suppression flavor</td>
<td>white capsule</td>
</tr>
<tr>
<td>HC5774</td>
<td>releases refreshing citrus flavor</td>
<td>yellow capsule</td>
</tr>
<tr>
<td>HC5884</td>
<td>adds a refreshing green tea flavor</td>
<td>orange capsule</td>
</tr>
</tbody>
</table>

**key benefits:**
- adds exciting visual effect
- delivers flavor
- provides texture and sensory signals
- isolates and protects ingredients

**captivates™ GL encapsulates**

Captivates™ GL encapsulates series are small particles that contain materials dispersed in a continuous hydrogel matrix. The GL encapsulate are made using JetCutter™ technology, which forms a hydrogel matrix that can entrap insoluble powders, oils and water-soluble actives. The process produces a uniform bead matrix, ranging from 250 to 3,000 microns, with high levels of encapsulated materials. Naturally derived materials such as chitosan, algicides and carrageenan can be used as the matrix material. The biopolymers used are biodegradable. Delivery triggers vary from dilution to pressure and temperature.

**toothpastes**

Captivates™ GL encapsulates enable the use of color in new and unexpected ways in toothpaste. These encapsulates can be designed to slowly soften and release color during brushing providing a gradual color-changing signal.
Committed to healthier, beautiful smiles

At Ashland, we are committed to making your oral care formulations delight consumers. We go beyond an innovative ingredient portfolio to provide local technical and sales support.

Ask us how we can help you achieve your formulation objectives.

Hydrogels

**Lubrajel® BA hydrogel**

Lubrajel® BA hydrogel is a clathrate of glyceryl acrylate and glyceryl polyacrylate that encloses water molecules via hydrogen bonding and Van der Waals forces. As supplied, this unique hydrogel contains about 50% water.

**Mouth moisturizers and mouthwashes**

As it binds moisture, Lubrajel® BA hydrogel helps provide relief from the feeling of a dry mouth. It imparts a combination of high mucoadhesion, hydration, and non-Newtonian rheological properties to mouth rinses, gels and sprays.

**Key benefits:**

- Provides hydration
- Adds shear thinning characteristics, just like natural saliva
- Enhances mucoadhesion to help hold moisture in the mouth
- Provides cohesive rheological properties
- Supplies lubricity for pleasant saliva-like mouth feel

<table>
<thead>
<tr>
<th>Grade</th>
<th>Chemical Description</th>
<th>Theoretical Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>BA</td>
<td>water, glycerin, butylene glycol, sodium polyacrylate, polyacrylic acid, benzoic acid, EDTA</td>
<td><img src="image" alt="Theoretical Structure" /></td>
</tr>
</tbody>
</table>

*Lubrajel is a registered trademark of United-Guardian, Inc.

Hydrogels

**Other**

**Allantoin**

**INCI Name:** allantoin

Allantoin, a white odorless crystalline powder, has been widely used in various dental preparations, such as toothpastes and mouthwashes. Allantoin is a skin protectant agent with both soothing and moisturizing properties.

**Key benefits:**

- Promotes a healthy environment
- Provides emollient properties
- Protects mucous membranes

<table>
<thead>
<tr>
<th>Grade</th>
<th>Chemical Description</th>
<th>Theoretical Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>allantoin USP</td>
<td>glyoxyldiureide</td>
<td><img src="image" alt="Theoretical Structure" /></td>
</tr>
</tbody>
</table>

![Theoretical Structure](image)
regional centers

North America
Wilmington, DE USA
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ashland.com/oralcare

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