Polymers II: Polysaccharides

MAKING COSMETICS

Classification of Polysaccharides

Anionic Polysaccharides

- Natural: Alginic acid, pectin, xanthan gum, hyaluronic acid, chondroitin sulfate, gum Arabic, gum karaya, gum tragacanth
- Semi-Natural: Carboxymethyl-chitin, cellulose gum

Cationic Polysaccharides

- Natural: Chitosan
- Semi Natural: Cationic guar gum, cationic hydroxyethylcellulose (HEC)

Nonionic Polysaccharides

- Natural: Starch, dextrins, guar gum
- Semi-Natural: Cellulose ethers (hydroxyethylcellulose, methylcellulose, nitrocellulose)

Amphoteric Polysaccharides

- Semi-Natural: Carboxymethyl-chitosan, n-hydroxy- dicarboxymethyl-chitosan, modified potato starch

Hydrophobic Polysaccharides:

- Semi-Natural: Cetyl hydroxyethylcellulose, polyquaternium 24

About Polymers (Part II): Polysaccharides

Polysaccharides form another important group of polymers. Polysaccharides are composed of multiple saccharides or sugars. They form a large, branched, or unbranched chain and are used in cosmetics that are natural or semi-natural. Based on their unique multi-functionality, they play a very important role in cosmetic formulation technology. For example, polysaccharides act as thickeners, suspending agents, hair conditioners, moisturizers, emulsifiers, emollients, and even wound-healing agents. However, the multi-functionality of polysaccharides might make formulation difficult. For example, a polysaccharide that conditions may do so at the expense of its thickening ability. Traditionally, polysaccharides are classified based on their electrochemical charges

Anionic Polysaccharides (negative charge)

Anionic polysaccharides are predominately comprised of naturally occurring materials. A major compound in this group is xanthan gum. It occurs on the cell walls of bacteria and is isolated by bacterial fermentation. In water, xanthan polymerizes to form viscous liquids with crystals with the unique ability to form emulsifier-free suspensions. Although the viscosity of xanthan solutions are influenced by cationic salts, xanthan doesn't require salts to build a viscous solution since it forms a rigid backbone that is remarkably stable during increasing temperatures. Xanthan also helps to reduce the number of primary emulsifiers. Due to these properties, xanthan gum is widely used as a thickening agent in the cosmetic industry. Hyaluronic acid and chondroitin sulfate are two other major components of anionic polysaccharides. Both of them are primarily used as moisturizers based on their great water-binding capacity (See newsletter No. 17, November 2005).

Gum Arabic, gum karaya, and gum tragacanth(is) are some of the oldest and commercially well-established anionic polysaccharides. They are isolated from the sap of specific trees and bushes. Gum Arabic consists of a chain of galactose sugars. Because of its low molecular weight, gum Arabic is mainly used in applications where high levels of sugar solids are desired without significant viscosity buildup. The maximum viscosity effect occurs at pH 6 but disappears quickly at higher or lower pH values. Gum Arabic dissolves in water and can bind fat particles, classifying it as an emulsifier. Anionic polysaccharides are only compatible with anionic, nonionic, or amphoteric surfactants (sulfosuccinate, polyglucose, or Cocamidopropyl betaine), but not cationic surfactants like quaternium-containing agents (used as conditioners). For example, the addition of quaternium 87 to a solution containing xanthan gum will make the xanthan to flocculate and settle out of the solution.

Cationic Polysaccharides (positive charge)

The cationic polysaccharides of cosmetic interest consist mainly of synthetically altered polyglycans. They have the unique advantage to bind tightly to proteins (negatively charged) of the human skin and hair. Cationic polysaccharides have therefore been found to be very useful as film-forming and damage control agents in conditioning hair and skin preparations. Cationic polysaccharides are also widely used in hair fixative formulations.

Cationic polysaccharides(positive charge) are commonly used in hair and skin conditioners.

The two most used cationic polysaccharides are cationic hydroxyethylcellulose (HEC) and cationic guar gum. There are two major cationic HEC available: HEC27 (polyquaternium 10) and HEC28 (polyquaternium 4). Both are widely used as a thickener and as hair repairing agents for bleached or heavily damaged hair. The thickening effect depends largely on the molecular weight of the cationic HEC. The higher the molecular weight, the more intense the thickening effect. Cationic guar gum has very similar properties to cationic HEC as it thickens and repairs damaged hair cuticles. One of guar gum's distinctive features, however, is the lubricious, creamy feel it lends to the formulations.

Nonionic Polysaccharides (no charge)

Nonionic polysaccharides are not charged and thus less affected by negatively or positively charged compounds as surfactants. Starch is one of the most used and is the least expensive natural nonionic polysaccharides, and it's mainly used as a thickener. By the addition of inorganic thickeners (bentonite) the thickening effect of starch can be increased significantly. A disadvantage of starch is that solutions become hazy. Guar gum, another non-ionic polysaccharide, has been found to be more appealing as a natural thickener. Guar is isolated from the seeds of various bean-growing plants and consists of two sugars, mannose, and galactose. Together with metal ions (borate), guar gum is able to create thick gels if the pH does not become acidic. Semi-natural nonionic polysaccharides are mainly ethers of cellulose or guar-based materials like hydroxyethylcellulose, methylcellulose, nitrocellulose, or hydroxypropyl guar. They are used either as thickeners, film-formers, or nail polishers.

No charge, no problem

Starch is one of the most used thickening and is one of the cheapest nonionic polysaccharides.

May cause solutions to beome hazy

Amphoteric Polysaccharides (2 charges)

Amphoteric polysaccharides carry both positive and negative charges on the same molecule. There are very few natural amphoteric polysaccharides used in cosmetics. Similarly, the semi-natural amphoteric polysaccharides, as carboxymethyl-chitosan or hydroxydicarboxyethylchitosan are relatively unknown and underutilized in cosmetics. They are challenging to formulate as they can change their solubility and show complex behaviors in the presence of surfactants or salts.

Hydrophobic polysaccharides great to use in gels or hair sprays.

Hydrophobic Polysaccharides

Hydrophobically modified (HM) polysaccharides are of increasing interest in cosmetics. By attaching lipophilic groups to the polysaccharides, they become less water-loving and show new and often unusual thickening characteristics. For example, the thickening effect of HM-HEC is no longer dependent on water, but on the concentration of the surfactant, which is a great advantage to formulate fixative gels or hair sprays.