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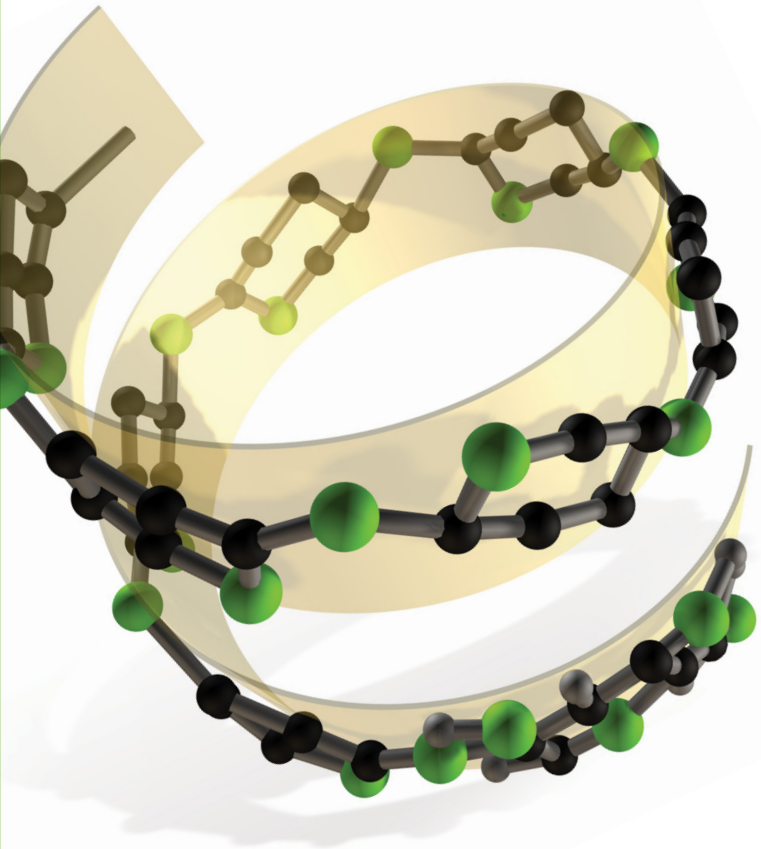
Changing the nature of plastics



High Amylose Corn Starch

Overview

Plantic Technologies Limited currently utilises chemically modified high amylose corn starch as its primary polymer in the manufacture of biodegradable plastics.

The basics

Starch is made up of glucose molecules linked together to form amylose and amylopectin. Most plants naturally contain about 20-25% amylose, but some, like certain species of maize (corn) starch have more than 50% amylose. The starch from this high amylose corn is commonly used in textiles, gum candies, cosmetics, pharmaceuticals (generally as a coating), biodegradable plastic products, numerous industrial applications and foods as an additive to increase the level of dietary fibre and lower the rate of energy release without changing the taste or texture. High amylose corn has amylose content between 50% and 90%.

There have been two recent advances that have increased interest in the use of high amylose starches that have resulted in increases in its production in the past decade. The first has been in the development of thermoplastic starch-based biodegradable plastics (TPS); Plantic's core use. Second, many food companies are looking at amylose from maize as a source of resistant starch (RS), a type of starch that is less susceptible to digestion than regular starch. As a food additive, consumers could benefit from added RS in foods since it will lower the glycemic index.

More than 100,000 acres1 (40,000 hectares) of high amylose corn is farmed each year. All high amylose corn is a non-GMO type specialty maize that utilizes traditional plant breeding techniques to increase the relative amount of amylose in the starch. US sources of this grain are identity preserved2 and therefore classified as non-GMO. It is generally grown under contract by farmers with agricultural technology companies and commands a substantial premium to the farmer, however, at least part of this is needed to off-set the fact that it yields only 75-80% as much, per acre, as regular corn.

All production is priced on a per bushel basis. The seed for high-amylose varieties is highly protected and there are no publicly available germplasm sources. The approximate starch yield from one bushel of high amylose corn is 55% (by weight) – this equates to 14kg (31lb) of starch per 25.4kg of corn kernels (59lb).

By contrast, the starch yield from ordinary corn is around 70%. In the U.S. high-amylose corn varieties have been grown and processed over the past 50 years mainly in the eastern corn-belt by two companies; National Starch and Chemical Company and Cargill. It is also grown and processed by Penford in Australia.

Starch modification

Unmodified starch generally lacks the versatility to function across the various processing techniques, distribution, storage and preparation conditions required of it. The two major drawbacks of high amylose corn starch are its very high cooking temperature and rapid rate & extent of retrogradation (recrystallisation).

These needs are typically met by modifying the starch, to a small extent, through either physical or chemical methods.

The most common form of modification is by the treatment of starch with small amounts of chemical reagent. Most modifications take place in reaction vessels wherein the necessary reagents, heat and pressure are applied to the starch.

The natural retrogradation of starch is inhibited by substituting the hydroxides on the starch polymer with chemical groups unlikely to form hydrogen bonds with nearby starch molecules. This significantly reduces the likelihood of retrogradation, allowing the starch to remain “shelf stable” for extended periods. Other beneficial physical properties are also derived from the modification of starch, such as reduced cooking temperatures and freeze-thaw stability.

Economics

The economics of this material are largely driven by the cost of;

- Maize (corn) production; contracted by the agricultural company who owns/controls the germplasm source. Factors include crop yield, processing, transportation and storage.
- Wet milling, starch extraction yield and associated production efficiencies.
- The cost and efficiency of chemical modification to the starch.

1 Plantic estimate – no commercial/public information available
2 Certified as less than 0.9% of other genetic material to allow for contamination through grain transfer , handling and storage systems