Why Mass Production Matters in the Dream of PHA Bioplastics

To Truly Succeed, Bioplastics Require Strength During Production and While in Use

By Laura Mauney

Making truly competitive materials to serve as biodegradable replacements for petrochemical plastics is one of the greatest challenges facing manufacturers of biopolymers.

Though "cost effectiveness" certainly comes to mind when the word "competitive" is attached to a product, in biochemical manufacturing, "competitive" takes on an entirely different meaning.

Consider the depth and complexity of planning and analysis that originally went into the development of the biopolymer *Nodax*^{TM} PHA.

Dr. Isao Noda of MHG

Invented by and named for chemical engineer Dr. Isao Noda, *Nodax*^{TM} PHA was originally patented in 1998 by Procter & Gamble as a compostable plastic film backing for paper-based diapers and sanitary products. Many other patents based on the *Nodax*^{TM} technology were filed by P&G following the original patent. The full set of patents was purchased in 2007 by Meredian, now known as MHG (Meredian Holdings Group).

Under the leadership of Dr. Paul Pereira, Executive Chairman and CEO of MHG, PHA is being further developed into an entire family of new biopolymers with a wide range of product applications.

The Road from Alpha to Ωmega

The original idea behind the *Nodax*^{TM} PHA project was to create a material that functions well as a replacement for conventional plastic, and that does not muck up landfills with non-degradable trash.

The objective sounds simple on the surface, especially considering that plastics made from renewable plant matter, like cellophane (from trees), have been around since 1838.

However, in reality, the Alpha to Omega challenge of creating a biopolymer capable of surviving the multi-faceted rigors of mass production and mass-market expectations was much more difficult.

Factors Dr. Noda and his team considered included creating a comfortable, waterproof, biodegradable substance that was strong, heat resistant, and adhesive friendly.

For *Nodax*^{TM} to be genuinely useful, it had to:

- Survive high-speed processing machines during manufacture without tearing or disintegrating
- Bond successfully with adhesives so it can be attached to other materials, like paper
- Withstand high temperatures during manufacture and storage
- Adapt to a wide range of product applications
- Resist rupturing, tearing and melting while in use

- Be fully compostable and biodegradable in all environments after disposal.

Nodax^{TM} PHA belongs to a type of polyesters called polyhydroxyalkanoates. Created by microorganisms during the fermentation of natural "esters" – fatty acid compounds – polyhydroxyalkanoates also include PHB (poly-(3-hydroxybutyrate)), PHBV (poly(3-hydroxybutyrate-co-3-hydroxyvalerate)), and PHBHx (poly(3-hydroxybutyrate-co-3-hydroxyhexanoate)).

PHB and PHBV possess many of the same positive environmental characteristics as PHA, including natural UV resistance. However, manufacturing problems with PHBs include a high melting point that is too close to the thermal degradation temperature, and hard and brittle mechanical properties, which make the PHBs unusable for many applications.

How Dr. Noda Solved the Problem

Celebrated for his development of two-dimensional infrared (2D IR) correlation spectroscopy, Dr. Noda discovered a new way to create much more useful polyhydroxyalkanoates while analyzing biopolymers in the lab.

Says Dr. Noda, who now serves as MHG's Chief Science Officer, "When 2D IR spectroscopy was applied to the characterization of previously known (and not so great) PHA materials without any mcl [medium chain length] branches, it provided a very significant insight into how this class of material can be redesigned to possess much better performing molecular structure. Spectroscopic evidence suggested that the physical properties of PHA should be greatly improved by simply extending the length of side branches. This prediction was later confirmed by chemical and biosynthesis of new PHA molecules that had never been seen before."

Polymers like PHA are essentially large molecules (macromolecules) composed of smaller, repeating molecular units, or monomers. DNA, rubber, and paper are polymers, for example, just like polystyrene and many other plastics.

When polymers are referred to as "plastics," that most often means that the material has plastic qualities, meaning that it can be bent and shaped without breaking easily.

Nodax^{TM} is called a biopolymer because it is sourced from biological organisms, namely microbes that feed off of vegetable oil. *Nodax*^{TM} is also 100% biodegradable and compostable in soil, salt water and fresh water.

The polymeric construction of *Nodax*^{TM} PHA is isotactic, meaning that its repeating molecules are regularly arranged in a fixed pattern in the space.

The unique composition of PHA makes it more durable than other types of bioplastics. PHA resists damage from UV sunlight, heat (up to 180° Celsius), and mechanical force, and blocks out liquids and gasses better, including water, oxygen, CO_2, and many toxic contaminants. MHG, to preserve the biocompatible nature of the product, makes PHA without the use of toxic additives or solvents.

Greater Performance, Less Trash

Some of the most impressive characteristics of *Nodax*^{TM} PHA are its adaptability to many applications and its ability to improve technologies in other fields.

Nodax^{TM} can be used to make toxin-free biodegradable and compostable films, sheets, fibers, foams, molded articles, nonwoven fabrics, elastomers, and adhesives. Significant outcomes include its applications in household products, medicine, and disposable, single use items.

For example, in disposable diaper construction, *Nodax*^{TM} can be used for the elastic in the leg bands, the top sheet, the fastening tabs, as well as the absorbent core and waterproof backing.

In addition to disposable diapers and sanitary products, plastic trash bags, shopping bags, beverage cup straws and lids, protective seals, all manner of packaging and packing materials, and even disposable cleaning wipes can be made of PHA.

Dr. Pereira explains, “MHG is the only company in the world to have been granted marine biodegradability OK status by Vinçotte. This is a milestone event for MHG as it differentiates our product from everything else worldwide.”

Says Dr. Pereira, “The potential medical applications of *Nodax*^{TM} are likewise impressive. As a nonwoven fabric, PHA can be used for medical drapes, gowns, masks and feet coverings. Enhanced by its value as a biocompatible substance, PHA can even be used to make surgical stitches and implants.”

For common household applications, *Nodax*^{TM} nonwoven fabrics can also be used for air, gas and allergen filters, quilt batting, and insulation. PHA can be formed into strong plastic substances to make toys, beverage bottles, containers for personal care and cleaning products, a host of food storage and service items, and many other durable goods.

Pollution caused by petrochemical plastics extends far beyond landfills, into the air, onto the streets, into waterways and oceans, and even into our bodies.

The mass production and biodegradable qualities of *Nodax*^{TM} make it one of the world’s best hopes for deterring the huge volume of petro-plastic waste generated each day.

Further, Dr. Pereira states that “PHA’s adaptability to a wide range of products will enable society to preserve the most valuable characteristics of plastics while offering a genuinely bio-friendly companion to the eco-friendly concepts of reducing and

reusing. Our vision of providing solutions for a healthier planet is truly being birthed before our eyes."

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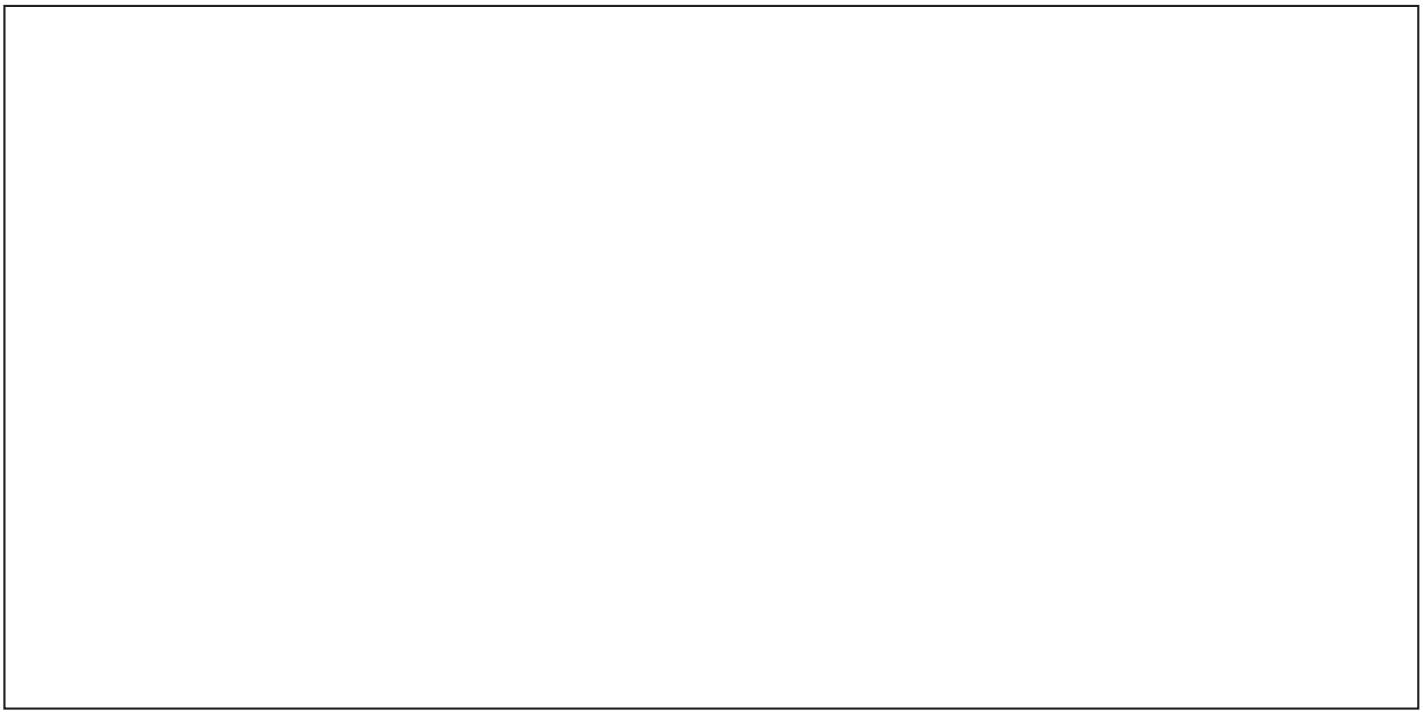
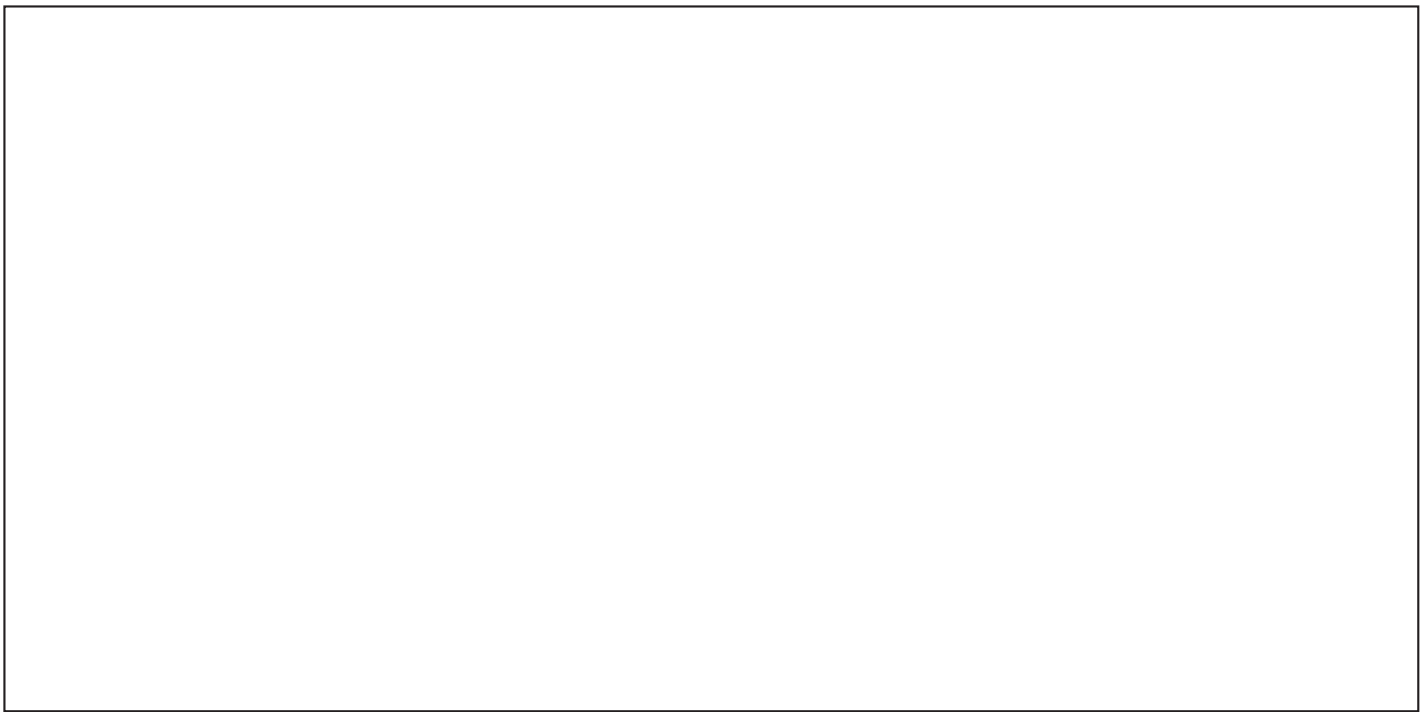


MHG – providing solutions for a healthier planet



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