

New Avenues in Recycling: NIR and Other Technologies Sort PET and Bioresin Bottles

**Dan Sawyer, Principal Applications Engineer and
Bottles Development Leader, NatureWorks LLC**

February 23, 2009

Following an analysis of current technology*, NatureWorks LLC concludes that automated systems being used today in the recycling industry are capable of sorting PLA-based bioresin bottles from other plastic bottles with an accuracy approaching 100 percent. For example in a recent field test** 93 percent of the PLA bottles were removed from the clear PET stream. The resulting clear PET bail contained just 453 parts per million PLA. The bails were 99.95 percent PET and plastics other than PLA following the sorting test. The field test** referenced above was conducted in early 2009. The finding is significant because it demonstrates that there is no technological barrier to recycling bottles made from plants instead of oil.

“To become more sustainable, the packaging industry must lower the overall waste, energy consumed, and greenhouse gas emitted from the use of plastics, metals, and fibers,” said Steve Davies, NatureWorks director of communications and public affairs. “Demonstrating that natural plastic bottles can be brought seamlessly into the recycling stream through the use of automated sorting equipment available today is a major finding and another step towards greater sustainability. It is clear that as of yet these machines are not available at every recycling operation. We hope that as the rates of recycling increase in the U.S. that operations will invest in this automation technology.”

Recycling is a business

There are markets for the metal, glass, paper, and plastic collected at recycling centers. Recycling centers must sort the materials into various

streams and then sell them for eventual reprocessing. Accurate sorting is at the heart of making recycling an economically viable system because the recycling operation must be able to accurately sort materials into pure streams — aluminum separated from steel or the highly valued PET and HDPE plastics from other polymers of less commercial value.

The typical plastics used today are known by such acronyms as PET, HDPE, PVC, and PS. In the last several years, new plastics made from renewable resources, such as plant-based materials, have come onto the market. Some of these biopolymers are made from Polyactic acid, which is commonly referred to as PLA. NatureWorks LLC proprietary PLA-based biopolymer is marketed under the Ingeo™ trademark.

Equipment manufacturers have developed systems that can automatically sort different types of plastic. The earliest automated equipment used the x-ray fluorescence technique to separate a relatively new plastic at the time, PET, from the predominant high-value material of the day, PVC. To accommodate today's many different types of plastics, equipment suppliers have developed new approaches, for example near infrared, and have continued to perfect x-ray, ultraviolet (UV), and other optical systems.

Sorting Technology

Near-infrared sorting is a preferred plastics sorting technology today because it can accurately identify different polymers. Polymers are unique constructions of carbon, hydrogen, and oxygen. When exposed to near-infrared light waves, different polymers reflect an identifiable spectrum. Unlike x-ray fluorescence, the earliest plastic sorting technology, the unique

characteristics come from the organic nature of the polymers, rather than a single ion or element.

The recycling industry has been concerned that the new biopolymers might contaminate the PET stream and about how to identify one from the other. WRAP, the internationally recognized not-for-profit company that helps individuals, businesses, and local authorities to reduce waste, conducted a comprehensive assessment of the technical, environmental, and economic viability of recycling domestic mixed plastics packaging waste. Published in June 2008, *Domestic Mixed Plastics Packaging Waste Options*, WRAP concluded that, “NIR (near-infrared) systems can effectively remove PLA bioplastic and carton board from a mixed packaging stream.”

Manufacturers

A number of companies have developed systems that can be used to effectively sort plastics not only with near-infrared, but also using ultraviolet, x-ray, laser, polarized light, fluorescent light, electrostatic, melt point, and other combinations of sorting techniques.

The following companies supply automatic detection and sorting equipment.

Supplier	Website	Sorting Technology/Technologies
Titech	www.titech.com	near-infrared bottle sorting
Unisensor	http://unisensor.luvenonet.de	laser flake sorting
MSS	www.magsep.com	combination near-infrared and color systems, other non-plastic sorting systems
NRT	www.nrtsorters.com	infrared, color and combination bottle sorting,

		and also flake sorting
RTT	www.rtt-zittau.de	near-infrared, x-ray, color, combination
S + S	www.se-so-tec.com	near-infrared, flake color
Rofin	www.rofinrapidsort.com.au	near-infrared/color combination
Pellenc	www.pellencst.com	near-infrared, color, combination
Binder + Co	http://www.btw-binder.at	near-infrared, color
Satake	www.satake-com.au	infrared, visual, color (CCD)
Mikrosort	www.mogensen.de	particle size
Mogensen	www.mogensen.de	color, x-ray

NatureWorks LLC Testing

NatureWorks LLC is committed to responsibly introduce its Ingeo biopolymer into the market. Over the last several years, the company evaluated the ability of a number of these sorting technologies. The following is a summary of these evaluations. The following is a summary of information provided to NatureWorks by the manufacturers referenced.

- TiTech has tested the ability of its near-infrared sorting systems to eject concentrated amounts of PLA in a PET sorting operation. Sorting efficiency in a single pass was found to be a minimum of 97.5% accurate. This is consistent with sorting efficiencies for other materials the equipment ejects as contaminants or passes through as desired streams, at similar incoming levels of 10%. Video documentation shows this successful sorting can easily be tuned to eject PLA as a contamination or collected stream. TiTech’s near-infrared sorting is probably the most dominant near-infrared technology employed worldwide.
- Unisensor has shown its laser flake technology is fully capable of sorting PLA flakes from desired PET recycle streams at efficiencies as high as 96-99%. This is consistent with other plastics considered contaminants in the PET flake sorting technology. This technology allows more or less sensitivity to be adjusted for specific materials, depending on the incoming stream composition changes.
- MSS tested PLA in its Aladdin near-infrared system. The test confirmed that PLA emits a unique polymeric “signature.” The test demonstrated

that PLA comes up as “other plastics” in a system specifically designed to identify PET, PE, and other plastics. Its unique signature means that the equipment could be programmed to identify PLA as PLA or simply as “other plastics.”

- NRT did not test PLA, but the company believes that its near-infrared systems should be capable of sorting PLA from the PET recycle stream.

Ingeo and other PLA bottles can be sorted using near infrared and other technologies described in this white paper, and then, once separated from the PET waste stream, can either be sent to landfills along with many other plastics, or recycled as a separate value stream. Like most plastics today, PLA can also be incinerated to recover energy. Under ideal combustion conditions, the products of incinerating PLA are water vapor, carbon monoxide and carbon dioxide. Ingeo and PLA used in food packaging and utensils can also be sorted, collected, and industrially composted in those areas offering this service. While this number is not currently large — BioCycle Magazine estimates 130 nationwide taking paper and other compostable products, it is hope that this number will grow. Visit www.findacomposter.com for locations nearest you. Composting diverts food contaminated waste from landfills.

Once volumes of Ingeo and other PLA-based bottles increase a recycled materials market may develop. Effective sorting technologies, such as near-infrared, will be useful for separating these bioplastics into a high-value stream. PLA can be reprocessed for new uses through either traditional mechanical means or recovered through chemical recycling — hydrolysis — which is an efficient method of reconstituting the biopolymer for new uses.

Since the first x-ray technology to sort contaminating PET from PVC recycle streams decades ago, a range of methodologies have been developed to identify, sort, and collect plastic materials. Near-infrared and color sorting technologies have been demonstrated to be an effective means for positively (ejecting to collect) or negatively (allowing to pass to collect) sorting. Industry experts conclude that there are a number of very effective automated sorting techniques that can be used to sort PLA bottles or flake from PET and avoid contamination of this important stream. Once NatureWorks LLC Ingeo and other PLA bottles are in the stream at a significant level, the technologies described here can be used to sort the bioplastic for collection and reprocessing for new uses.

Continued conversion of recycling facilities to near-infrared and other automated sorting technologies will improve sorting at recycling operations so that the plastic streams are purer and more material is recycled, incinerated, or composted. Furthermore, there will be less environmental impact from packaging as increased volumes of plastics are diverted from landfills.

A timeline of bottle-related milestones and a lifecycle analysis by Energy and Environmental Research can be downloaded from the News and Events page of the company's website, www.natureworkslc.com. NatureWorks also publishes a newsletter covering developments of Ingeo™ bioresin and relevant industry developments — see the News and Events page.

About Dan Sawyer

During his 14 plus years in the bioplastics industry, Dan Sawyer has worked with NatureWorks LLC in a variety of positions ranging from analytical to manufacturing, applications development and technical support. After a three-year assignment in Asia, Dan has returned to play a key role in bottle and beverage technical and market development and end-of-life issues.

About NatureWorks LLC

NatureWorks LLC is a company dedicated to meeting the world's needs today without compromising the earth's ability to meet the needs of tomorrow. NatureWorks LLC is the first company to offer a family of commercially available biopolymers derived from 100 percent annually renewable resources with performance and economics that compete with oil-based plastics and fibers. www.natureworksllc.com.

Ingeo and the Ingeo logo are trademarks or registered trademarks of NatureWorks LLC in the USA and other countries

*The Benefits and Issues of Sorting Plastics for Improved Recycling — With Special Emphasis on PLA: By Dan Sawyer, Principal Applications Engineer and Bottles Development Leader, NatureWorks LLC. (Available at www.natureworksllc.com).

**  [Using Near-Infrared Sorting to Recycle PLA Bottles](#)