Crystal: The development of a photopolymer based additive manufacturing process for producing a unique no-label look decoration without a laminated face-stock.

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Crystal Overview

- ALTANA - ACTEGA North America
- Crystal Genesis
- Technology Concept
- Target Market
- Market Drivers
- Phase 1 Scale-Up Overview
- Label Performance Testing & Approval for Rigid Packaging
ALTANA - ACTEGA North America

ALTANA is headquartered in Wesel, Lower Rhine, Germany:

- is a global specialty chemical group
- has more than 6,000 employees to fulfil customer requirements
- consists of four divisions
- owns 49 production facilities as well as more than 50 service and research laboratories worldwide
- is 100% owned by Susanne Klatten (Quandt family, major shareholder of BMW)
### ACTEGA North America (Packaging Value Chain)

<table>
<thead>
<tr>
<th>Primary Materials</th>
<th>Secondary Materials</th>
<th>Type of Package</th>
<th>Producers/Packers</th>
<th>Brand Owners</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Paper/Board</td>
<td>• Printing inks</td>
<td>• Bottles</td>
<td>• Food</td>
<td></td>
</tr>
<tr>
<td>• Plastics</td>
<td>• Adhesives</td>
<td>• Cans</td>
<td>• Beverages</td>
<td></td>
</tr>
<tr>
<td>• Metal/Aluminum</td>
<td>• Overprint varnishes</td>
<td>• Paper boxes</td>
<td>• Pharmaceuticals</td>
<td></td>
</tr>
<tr>
<td>• Glass</td>
<td>• Printing auxiliaries</td>
<td>• Plastic trays</td>
<td>• Cosmetics</td>
<td></td>
</tr>
<tr>
<td>• Other (wood, etc.)</td>
<td>• Coatings</td>
<td>• Foils</td>
<td>• Non-Food</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Can sealants</td>
<td>• Bags</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Closure compounds</td>
<td>• Labels</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Others</td>
<td>• Pouches</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Others</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Genesis

ALTANA Acquires Pioneering Label and Packaging Technologies

- Acquisition of a technology portfolio and innovation team from U.S. based NuLabel Technologies, Inc.
- NuLabel develops engineering and material science solutions to improve packaging design while using significantly less material

Wesel (Germany) / East Providence (U.S.), August 10, 2017 – The specialty chemicals Group ALTANA has acquired a technology portfolio and research and development platform from U.S. based NuLabel Technologies, Inc. It comprises innovative technologies for additive manufacturing of sustainable decoration solutions as well as novel technology for resealable packaging. The environmentally friendly technologies allow for unique packaging design that uses considerably lower quantities of consumable materials. The acquired technologies will be integrated into ALTANA’s ACTEGA North America division, where they are to be developed to market maturity. ALTANA also takes over an interdisciplinary team of researchers. The parties have agreed not to disclose the purchase price.

“We are very pleased to have found a new owner in ALTANA who is in a position to integrate our innovation pipeline into its core business and to bring it to market readiness,” said Benjamin Lux, President of NuLabel Technologies, Inc. “We know that our innovation team and our technology solutions are in the best of hands with ACTEGA, a company that has long-standing experience as a leader of new and sustainable technologies for the packaging industry.” Mr. Lux will join the ACTEGA North America team and industry veteran Harold Schofield will continue leading NuLabel as interim CEO.

“NuLabel’s innovation team, intellectual property, and projects are an ideal addition to our growing portfolio,” stated Mark Westwell, President and CEO of ACTEGA North America. “They have the potential to provide new growth opportunities to our customers in the packaging industry, and, at the same time, to make an important contribution to sustainability.”
Concept: Process

- Crystal utilizes an additive manufacturing on existing conventional printing assets to produce a unique no-label look decoration without a laminated facestock.

- Decorations can be supplied through the existing label supply chain to packaging sites.

- With the use of modified application hardware, Crystal decorations are transferred to rigid containers and the carrier film is released at the point of application.

- The result is an ultra low-waste, premium no-label-look decoration previously unachievable with the dominant pressure sensitive label decoration techniques.

- The unique product and process deliver considerable value to brands and the supply chain:
  - Zero waste to landfill (>95% reduction in waste) for printers/converters
  - Ability to decorate at lower caliper than extruded films
  - Lowering the inbound raw material costs for printers
Concept: Joint Coatings & Application Hardware Approach

Coatings + Hardware Approach
- The Crystal Technology is a coatings and application hardware innovation to provide a new platform for container decoration
- To unlock the value of Crystal Media, design modifications need to be made to existing container decoration (labeling) hardware

Media
- ANAT develops coatings to be utilized on existing narrow web printing assets that allow printers to build Crystal Media
- No press modifications required

Hardware
- ANAT designs hardware modifications and partners with existing leading hardware suppliers

Brands/Packaging Sites
- Supplied Crystal Media from existing media supplier
- Supplied Crystal Compatible Hardware from existing hardware supplier
Concept: Pressure Sensitive Adhesives Labels - Schematic
Carrier Film: The LLL is deposited onto the topside of an extruded (recyclable) polymeric film between 2-3 Mils in total thickness. Dependent of the supplier backside of the film either has a release coating or treatment that will come into contact with PSA during winding.

Liquid Label Layer (LLL): The LLL is a coating applied in register using the initial print station. This clear coating acts as the label substrate during application and overprint varnish once applied to a container.
Concept: Crystal Decoration - Schematic

Print: Print (reverse) is applied in register using existing stations and ink.
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Print: Print (reverse) is applied in register using existing stations and ink.
Concept: Crystal Decoration - Schematic

**Pressure Sensitive:** Adhesive is applied in register using an existing print station. The adhesive footprint mimics the LLL footprint.
**Concept: Pressure Sensitive Adhesive vs. Crystal**

<table>
<thead>
<tr>
<th>Area</th>
<th>Conventional Clear Film PSA</th>
<th>Crystal Label</th>
<th>Crystal Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Label or Decoration Area</td>
<td>20 cm²</td>
<td>4 cm²</td>
<td>80%</td>
</tr>
<tr>
<td>Laminate Area</td>
<td>30 cm²</td>
<td>0 cm²</td>
<td>100%</td>
</tr>
<tr>
<td>Liner or Carrier Area</td>
<td>30 cm²</td>
<td>24 cm²</td>
<td>20%</td>
</tr>
<tr>
<td>Matrix/Waste Area</td>
<td>10 cm²</td>
<td>0 cm²</td>
<td>100%</td>
</tr>
<tr>
<td>Adhesive Area</td>
<td>30 cm²</td>
<td>4 cm²</td>
<td>86%</td>
</tr>
</tbody>
</table>

**Raw Material Reduction to Printer: >60%**
Concept: Application Hardware

- A variety of styles/designs of PS Labelers exist in the market today.

- Modifications to most existing Wrap-Around PS Labelers (focusing on the web path) are required to apply Crystal Labels to containers.

- Crystal Compatible hardware will likely be provided as new machines.
Concept: Application Hardware

Applicator Phase 1 Test Results:

- Sustained runs of >1,000 containers with Flexo printed generic media
- Consistent average throughput of >45 containers per minute with bursts of >100 containers per minute decorating rigid:
  - PET Containers
  - Aluminum
  - Glass
- Burst run speeds of >95 cpm

Above: Infeed rotary accumulator and label applicator.
Concept: Crystal Decorated Containers
Concept: Crystal Decorated Containers

Left: Sample artwork applied to PET containers
Center: Sample artwork seen through a BOPP carrier film
Right: Sample artwork with white backing prior to transfer from carrier film
Concept: Crystal Decoration Performance

**Solvent Resistance:**

- MEK double rub testing is a measure of fullness of cure of the liquid label layer (L3) which is the Crystal label decoration coating. All photopolymer based L3 formulations are developed to pass a minimum of 50 double rubs with MEK solvent.

**Scratch Resistance:**

- Crystal label decorations are less prone to scratching than the PET containers they get applied to. Scratch resistance is formulated into the L3 based on customer requirements.

**Abrasion Resistance:**

- For abrasion resistance, Crystal label decorations are tested via a Sutherland Rub tester simulating containers rubbing against each other while on packaging. Crystal label decorations (L3 with PSA applied to flat PET substrate) will survive ≥150 strokes before the label abrades.
Concept: Crystal Decoration Performance

**Recyclability:**

When selecting a primary/secondary label stock for compatibility with PET recycling, the following considerations are taken into account:

- Label stock impact on automated NIR sortation
- Can the label be “liberated” from the bottle and “separated” cleanly from the PET?
- Does the label impact the wash water used for recycling?
- How much waste and bale yield loss does the label create?
- Does the label contaminate the closure side stream?
- Will high surface area coverage labels be mis-sorted as colored bottles?
Concept: Crystal Decoration Performance

Recyclability:

- Recycling Protocol used: “Thermoform Label Test PET-S-04” (Assoc. of Postconsumer Plastic Recyclers)

  - Tier 5 (full press build) test.
  - Once in contact with the recycle bath the Crystal label drops from the PET container and breaks up into small pieces that are removed with the effluent.

Summary:

- Crystal passes the protocol with excellent separation of the Crystal labels from PET.
- The decoration can be dissolved in recycling bath as part of the recycling process, thus helping to move towards a higher quality post consumer recycle stream for high volume rigid container plastics.
Target Market: Label Type

<table>
<thead>
<tr>
<th>Total Market by Technology (2017)</th>
<th>Million Square Meters</th>
<th>% Share</th>
<th>% Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure Sensitive</td>
<td>24,918</td>
<td>40</td>
<td>5.2</td>
</tr>
<tr>
<td>Glue Applied</td>
<td>21,921</td>
<td>35</td>
<td>3.0</td>
</tr>
<tr>
<td>Sleeving</td>
<td>11,213</td>
<td>18</td>
<td>5.5</td>
</tr>
<tr>
<td>In-mold</td>
<td>1,243</td>
<td>2</td>
<td>4.2</td>
</tr>
<tr>
<td>Others</td>
<td>2,753</td>
<td>5</td>
<td>2.4</td>
</tr>
<tr>
<td>Total</td>
<td>62,048</td>
<td>100</td>
<td>4.3</td>
</tr>
</tbody>
</table>
Target Market: PET/HDPE Rigid Containers in the U.S.

- Approximately, 5.9MM lbs. of PET bottles were sold in the United States in 2017.
- 1.7MM lbs. or 29.2% were collected through recycling programs and sold either to domestic or foreign markets. (Gross Recycling Rate)
- The total amount of PET recycled at U.S. material recovery facilities (MRF) has been in decline since 2014. Major causes of decline include:
  - rPET price erosion due to an increase in quality standards based on China Sword.
  - PET container light weighting
  - Bigger, faster material recovery systems leading to material misdirection
  - Increase in the use of single stream collection leading to increased contamination rates.

Note: The collection of high-density polyethylene (#2) bottles, which includes bottles for milk, household cleaners, and detergents, fell by 70.3 million lbs. (6.3%) to just over 1MM lbs. in 2017. The recycling rate for HDPE bottles slipped from 33.4% to 31.1%.
Market Drivers

- Currently, estimate – 8-12 million tonnes of plastic enters the ocean each year and staged to grow rapidly.
- The only developed country in the top 20 list of ocean plastics is the U.S.
- Only 9% of all plastics ever produced have been recycled; the rest were landfilled, burned or released to the environment.
- Consumer backlash is growing and has taken the form of personal pledges, calling for the elimination of single-use plastics and plastic-free grocery aisles – esp in Europe.
- Significant regulatory and voluntary corporate responses.
  - Country/State/Local Bans, EPR, taxes
  - Starbucks, Kroger, Icelandic Foods, Sandals & Caesars Resorts
- Global brands and retailers are scrambling to respond.
Market Drivers

China’s National Sword

China banning all imports of scrap materials by 2020

- The U.S. exported $16.5 billion in scrap last year, more than any other country.
- Paper and plastic were about $3.9 billion of that
- Over 40% of US discarded-plastic exports ended up in China last year

That’s more than exports to China of wheat, rice, corn, meat, dairy and vegetables combined

lsri.com

This is a devastating impact to the recycling industry. Recycling is changing and will become more expensive
Market Drivers

• In the U.S. the Ellen MacArthur Foundation is leading the New Plastics Economy – a three-year initiative to build momentum towards ‘a plastics system that works’. Applying the principles of the circular economy, it is brings together key stakeholders to ‘rethink and redesign’ the future of plastics, starting with packaging.

• As of October 2018, major brands and retailers signing the commitment include:

Burberry Group, Carrefour, Coca-Cola, Colgate-Palmolive, Danone, Diageo, H & M, Henkel, L’Oréal, Marks and Spencer, Mars, Nestlé, Philips, SC Johnson, Sealed Air, Stanley Black & Decker, Target, Unilever and Walmart.

Signatories also include major waste management companies: Suez and Veolia; a number of municipal and national governments, including Chile, France and the UK; and 150 or so endorsers.
Market Drivers

In January 2018, the European Commission adopted the first-ever Europe-wide Plastics Strategy as part of its transition towards a more circular economy. Under new plans, all plastic packaging on the European Union market will be recyclable by 2030.

In December 2018, the European Commission launched a new “alliance” of key industry stakeholders covering the full plastics value chain as part of its efforts to increase the share of recycled plastics and stimulate market innovation in the EU.

New EU Packaging Directive Recycling Targets:  
Today: 22.5%  
2020: 50%  
2030: 100%  

Single Use Packaging Directive:  
90% bottles collected by 2030 (58% recycled today)  
30% recycle content by 2030  

Note: EU member states at risk of meeting 2020 target are: Bulgaria, Croatia, Cyprus, Estonia, Finland, Greece, Hungary, Latvia, Malta, Poland, Portugal, Romania, Slovakia and Spain.
Summary

• Crystal decorating technology utilizes **existing Flexographic / piezo Inkjet printing assets** to produce a unique no-label look graphic without a laminated face stock at conventional press speeds.

• Crystal decorating technology reduces overall label material requirements by +50% and under optimum conditions allows for the complete recycling of rigid plastic containers.

• Crystal coatings, inks, adhesives and carrier film can be supplied through the existing label supply chain to label and flexible packaging printing and converting locations.

• With the use of modified application hardware, Crystal decorations are transferred inline to containers. The carrier film is removed at the point of application and can be recycled.

• The result is a low-waste, low-cost, premium no-label-look decoration previously unachievable with pressure sensitive label techniques.
Thank You!

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