Let's make it work!
Plastics from renewable raw materials

Dr. Jürgen Herwig
December 4, 2013
focus on high-performance polymers

Cost driven

Performance driven

High-performance polymers

Commodity polymers

Engineering polymers

= Polymers by Evonik

= Semi-finished products by Evonik

December 4, 2013 | F&E press conference | Plastics from renewable raw materials
BioLL stands for ‘bio-based lauryl lactam’

Lauryl lactam is the basis for polyamide 12 – an important high-performance plastic that is used in many industries

- Soles of shoes for the sports industry
- Brake pressure lines
- Offshore pipelines
- Powder coating for dishwasher racks
Economy and ecology are not contradictory terms

Raw oil-based LL process

- Raw oil
- Naphtha benzene
- Crack C4 fraction
- Butadiene
- 5 more chemical stages
- Lauryl lactam
- PA12

Bio-based process (BioLL)

- Palm kernel
- Palm kernel oil
- Lauric acid methyl ester (LAME)
- 12 aminolauric acid methyl ester (ALAME)
- LL equivalent (ALA)
- PA12

Fermentation

Fermentation processes are profitable if the number of chemical stages can thereby be reduced
### Challenge

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strain development</strong></td>
<td>Stable strain with high productivity, selectivity</td>
</tr>
<tr>
<td><strong>Process development</strong></td>
<td>Stable process with little need for capital, and low energy and steam consumption</td>
</tr>
<tr>
<td><strong>Reprocessing</strong></td>
<td>Highly purified product easily reprocessed for polymerization (Polymer Grade)</td>
</tr>
</tbody>
</table>

**Problem:**

The product required was damaging to the cells. This is similar to alcohol fermentation where the alcohol becomes toxic to the yeast after a certain concentration.
The solution: 2 phase fermentation

The product is extracted during fermentation using another fluid.
Our asset: combined technology skills

Fermentation technology
Reprocessing process science

Polymer science
Acquiring patents

Strain development

New technology & processes
Several million € were invested into constructing a pilot facility for manufacturing BioLL at the site in Slovenska Lupca.

- Specialized Evonik site for fermentation with good infrastructure
- Staff with a lot of motivation and skills in fermentation

The pilot facility’s objectives are to wire up fermentation and downstream processes and to scale up the process.
Summary and prospect

- New fermentation technology was developed, product is extracted in situ.
- This was only possible through interdisciplinary cooperation.
- Evonik has registered approximately 20 patent families in the BioLL sector.
- The new process can supplement crude oil-based production of PA12 on a long-term basis.

The development of the fermentation process for the polyamide precursor stage ω-amino lauric acid (ALA) was subsidized by the Federal Ministry of Education and Research.