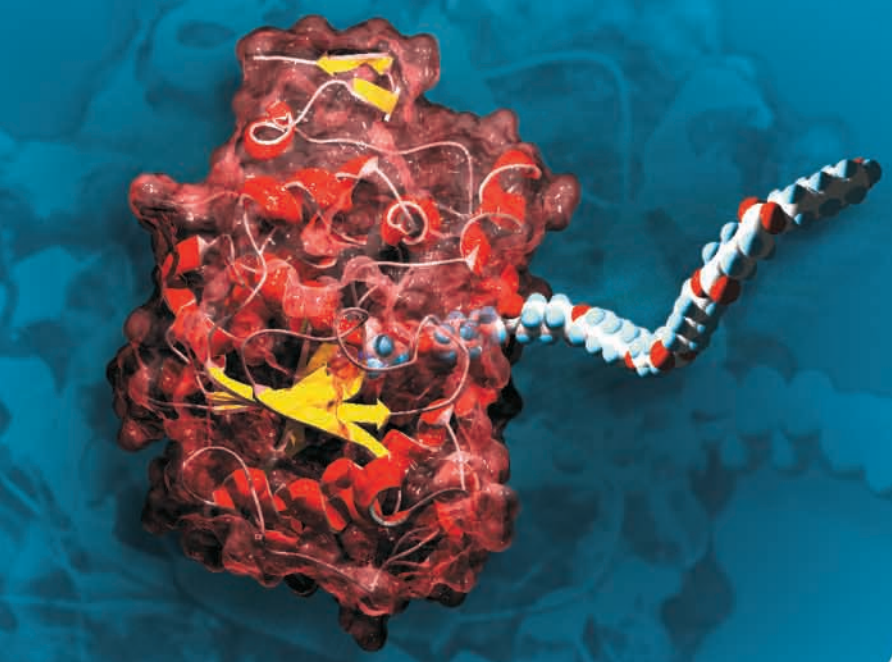
BIO-WISE
Biotechnology at work

ACTION PROFILE



"This project successfully demonstrates the novel use of bio-catalysis in an industrial polymerisation process. Enzyme catalysed polyesters of various molecular weights have now been manufactured on a large scale."

Norman Gee,
Managing Director,
Baxenden Chemicals

New enzyme-based bioprocess saves energy and improves product quality

This action profile describes how a UK chemical company took a pro-active stance in self-funding the development of new technology to use enzymes in an entirely novel way to make polyesters. Key benefits to the company are:

- Breakthrough with a new technology in an old established market
- Lower temperature processing due to the use of a new powerful, robust enzyme
- Improvements in environmental performance together with economic benefits

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The challenge faced

UK-based Baxenden Chemicals has been established for 30 years. It has the largest polyurethane dispersion manufacturing facility in the UK and sits at the forefront of polyurethane technology. In 1992, the company began to explore the feasibility of using enzyme technology to produce novel polyesters. A successful collaboration with an academic institution was key to success. Enzymes were known to be very powerful catalysts, but were regarded as sensitive to acid and particularly 'uncomfortable' in non-water based media. The idea was to test their application in this harsh environment. Previously, their use in the cosmetic industry had been proven, but under far less demanding conditions.

The vision was 'a perfect polyester', capitalising on the power of control of the new catalyst to deliver a more ordered architecture, and hence improved molecular chain stacking.

The niche market targeted was that of high molecular weight polyesters for the adhesive business. Theoretically, lower temperature processing would enable higher molecular weight build-up. There was a possibility of sharper crystallinity, resulting from better packing of the component polymer chains. Another idea was the switch to relatively unstable diols, incompatible with high temperature processing. These would then open the door to novel polyurethane derivatives.

Actions taken

Preliminary research supported totally by Baxenden showed that the concept was practical in organic solvents using *Mucor miehei* lipase. The research was then transferred in-house and developed to give a solvent-free process using the new, robust *Candida antarctica* lipase, CALB. A sacrificial catalytic system was tested, but proved less practical, so enzyme recyclablity was finally chosen as the best option.

Subsequently, extended collaborative academic research demonstrated a different method of chain growth due to the special enzyme catalysis.

High molecular weight polyesterification was achieved, and the polyesters had different physical properties to the conventionally produced analogues. Theoretical studies led to reasons for this novel effect, due to the unique nature of the catalyst which gave a dedicated terminal step-growth chain growth; tighter control contrasting with the conventional mix of chain growth/chain scission.

The new polymerisation process eliminates the use of a toxic catalyst, and the lower process temperature results in reduced energy use. Traditional methods for manufacturing polyesters require the use of a titanium or tin-based catalyst at temperatures above 230°C. The polymer arising from the bioprocess has a more uniform molecular structure. The polyesters can be used to manufacture polyurethane reactive hot melt adhesives with improved green strength and rapid setting characteristics.

The benefits of the new enzyme-based bioprocess are:

- A much safer product due to the elimination of a toxic catalyst.
- Cost savings through reduced energy use.
- Environmental and health benefits for workers in industries using adhesives based on bioprocess polyesters rather than traditional adhesives.
- A novel, speciality product giving the company a leading edge in a number of fields where polyesters are used.
- Possibility of further diversification to novel, heat sensitive diol building blocks.

Further information

Baxenden Chemicals: www.baxchem.co.uk

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