Chemical Modification of Polyhydroxyalkanoates

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THE UNIVERSITY OF SYDNEY

Medical technology and devices

> TRL 2-3

Executive statement

This technology chemically modifies polyhydroxyalkanoates by bonding them with polyamines to enhance their thermal, mechanical, and processing properties for advanced biomedical applications.

Solution

This innovation involves creating block copolymers comprising polyhydroxyalkanoate (PHA) blocks and polyamine blocks, particularly polyurethane-polyethyleneimine (PU-PEI) blocks. Chemical modification via aminolysis attaches PU-PEI to PHA backbones, such as poly(3-hydroxybutyrate-co-4-hydroxybutyrate) (P(3HB-co-4HB)), reducing crystallinity, lowering melting points, and improving flexibility and processability. The modified PHAs exhibit enhanced surface charge, increased hydrophilicity, improved mechanical strength, and reduced swelling. These copolymers can be melt-extruded into filaments suitable for biomedical uses like sutures, overcoming limitations of brittle and high melting point native PHAs.

Intellectual Property Status

Provisional application 2025900616

Key advantages

- Significant reduction in melting temperature (up to 12°C lower) facilitating melt processing.
- Improved flexibility and toughness, enabling filament formation and knotting.
- Enhanced mechanical properties including doubled ultimate tensile strength and increased Young's modulus.
- Increased surface hydrophilicity and positive surface charge improving biocompatibility.
- Reduced swelling ratio for stability in aqueous environments.
- One-phase chemically bonded copolymer avoids phase separation issues of physical blends.
- Tailorable properties by adjusting polyamine content and reaction conditions.

Problems solved

- Brittleness and high crystallinity of native PHAs limiting application scope.
- High melting points of PHAs impeding conventional melt-processing techniques.
- Thermal degradation during processing reducing product quality.
- Hydrophobic surface limiting biomedical compatibility and functionality.
- Phase separation and anisotropic properties in polymer blends lacking chemical bonding.

Market applications

- Biomedical devices including implantable materials and sutures.
- Biodegradable and biocompatible polymers for drug delivery systems.
- Environmentally friendly bioplastics with improved processability.
- Advanced coatings and films requiring tailored surface charge and hydrophilicity.
- Manufacturing of flexible filaments for medical and industrial uses.

Inventors

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