

Ultra-high Strength Self-reinforced Bioabsorbable Polymer Composites for Surgical Applications

Pertti Törmälä¹, Pentti Rokkanen² and Timo Pohjonen¹

¹Institute of Biomaterials, Tampere University of Technology, P.O. Box 589, FIN-33101 Tampere, Finland

²Department of Orthopaedics and Traumatology, Helsinki University Central Hospital, Topeliuksenkatu 5, FIN-00260 Helsinki, Finland

We have developed methods by which thermoplastic, linear, partially crystalline or amorphous bioabsorbable polymeric materials can be transformed into the ultra-high strength, self-reinforced form. Self-reinforcing means that at least part of the molecular chains of polymer are oriented to a certain direction (usually parallel or helically) in relation to the long axis of the implant.

The most efficient method to create self-reinforced, oriented structure is mechanical deformation, like drawing of a polymer billet. The draw ratios between 2-12 are used typically in self-reinforcing of bioabsorbable polymers. As a consequence of drawing the normal spherulitic crystalline structure is transformed partially to an oriented, fibrous structure, leading to a significant increase of strength, modulus and toughness of the material. Also the strength and toughness of amorphous bioabsorbable polymeric materials can be increased significantly with the drawing - reinforcing technique.

Self-reinforcing transforms brittle polymers, like polylactides to tough ones simultaneously with the significant increase of mechanical strength properties. We have increased the bending strength of partially crystalline poly-L-lactide from ca. 100 MPa up to 300 MPa by drawing-reinforcing technique.

Self-reinforced polylactides can be machined to implants by means of mechanical processing and/or heat treatments. We have developed different types of bioabsorbable implants for surgical applications using self-reinforced polylactide as raw material.

Typical applications of self-reinforced, bioabsorbable implants in surgery are given in Table I.

Table I. Applications of self-reinforced, bioabsorbable implants in surgery

Surgical discipline	Implants	Applications
- Orthopaedics and Traumatology	Pins, screws, tacks	Fracture fixation
-Maxillofacial surgery	Screws and plates	"
-Dental surgery	Membranes	Guided tissue regeneration
-Urology	Stents	Stricture prevention

Self-reinforced, bioabsorbable implants retain their strength ca. 1-12 months *in vivo* depending on chemical and physical structure, size, geometry and location of the implant. The final bioabsorption takes ca. from 1 to 6 years depending on the same factors.

REFERENCES

P. Törmälä, Clin. Mater. 10 (1992) 29-34