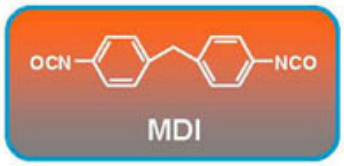
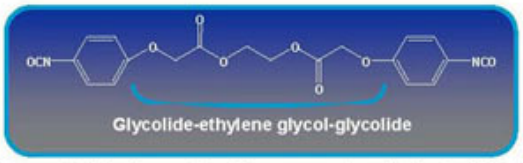
BOTM: July 2010

Novel Absorbable Polyurethanes

These absorbable polyurethanes were derived from highly reactive isocyanates that are similar to Methylene bis(phenylisocyanate) (MDI) but are biodegradable and have tunable hydrolytic degradation profiles [1-2]. What distinguishes these isocyanates from the commonly used isocyanate, MDI, is the presence of a degradable linkage bridging the aromatic rings instead of the non-degradable methylene group. Furthermore, the degradable linkage in our isocyanates is derived from safe and biocompatible glycolic acid, lactic acid, caprolactone, p-dioxanone and diols, examples of which are shown in **Figure 1**. A comparison between the prior art and our state-of-the-art is given below in **Table 1** below.

Table 1. Comparison between Prior art and Our State-of-the-Art

Prior Art	Our State-of-the-Art
	
• Non-degradable aromatic diisocyanates • Derived polyurethanes are biostable	R= degradable linkages derived from glycolide, lactide, PDO and caprolactone monomers and ethylene glycol.
	
	• Degradable Aromatic Diisocyanate similar to MDI • Derived from safe and biocompatible monomers • Degradation products: safe and biocompatible • Controlled degradation profile
	Renders derived polyurethane hydrolysable/absorbable

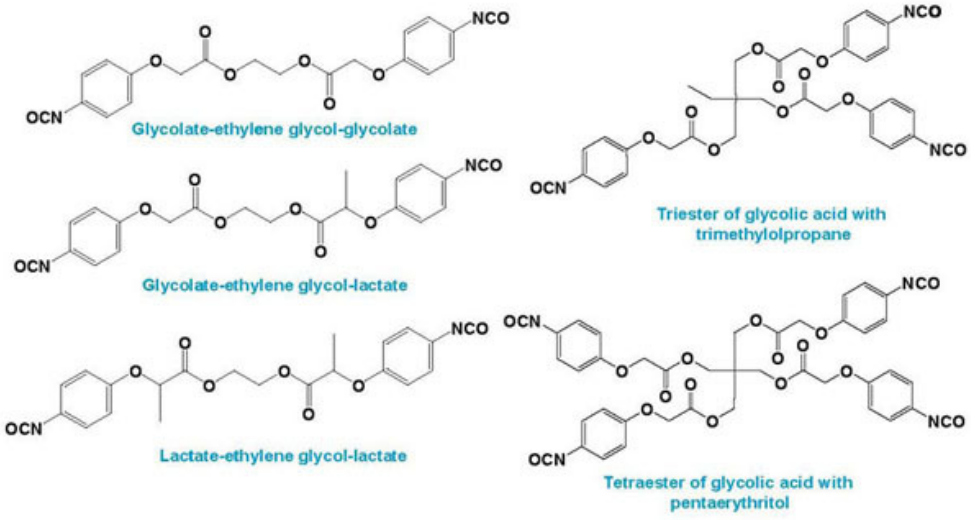


Figure 1. Selected examples of novel degradable aromatic isocyanates

Hydrolytic degradation Profiles:

Figure 2 displays the results comparing the hydrolytic degradation profiles of two absorbable polyurethanes. Figure 2(A) displays the in vitro hydrolytic degradation profiles of absorbable

polyurethanes derived from isocyanates BB002 and BB004, chain extender 1,4-butanediol and polycaprolactonediol of average molecular weight 530 [3]. Similarly, figure 2 (B) compares the in vitro hydrolytic degradation profiles of absorbable polyurethanes derived from isocyanates BB002 and BB004 respectively with chain extender 1,4-butanediol and soft segment polycaprolactonediol of average molecular weight 530 and polyethylene glycol of average molecular weight 4600 respectively.

As can be seen from figure 1 and 2,

- The hydrolytic degradation rate of developed absorbable polyurethanes can be controlled by varying the chain length of the degradable linkage of the isocyanates and/or by varying the safe and biocompatible molecule within the degradable linkage of the isocyanate, i.e. replacing glycolide with lactide or p-dioxanone, and the like.
- Polyurethanes derived from these novel isocyanates and chain extender diols will be not only absorbable but will also possess, for the first time, degradable hard segments.
- Upon hydrolysis, the derived absorbable polyurethanes will degrade into safe and biocompatible degradation products, unlike polyurethanes derived from MDI

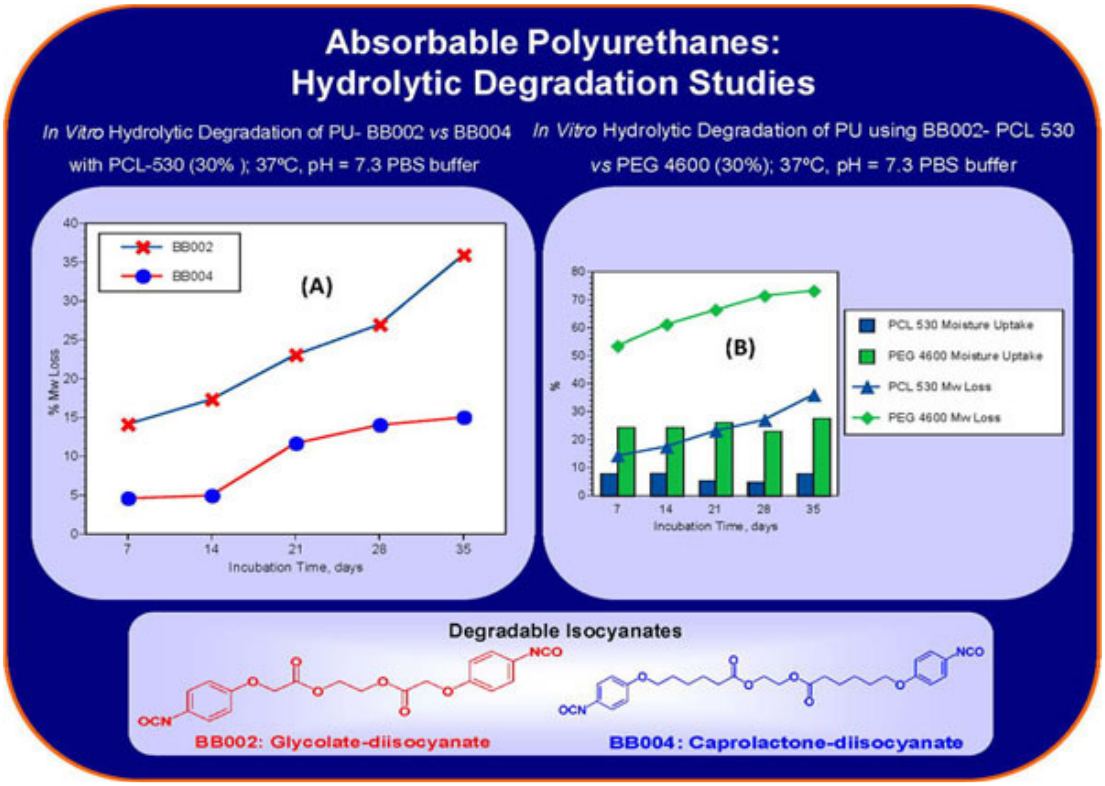


Figure 2. Selected examples of novel degradable aromatic isocyanates

Physical and Mechanical Properties:

The derived absorbable polyurethanes will have the toughness and mechanical properties of that of commercially available medical grade polyurethanes. For example, absorbable polyurethane derived from isocyanate BB002, chain extender 1,4-butanediol and polyethyleneglycol of average molecular weight 4600 has a maximum tensile strength of 7000 psi and elongation at break of 513%. This is comparable to commercially available medical grade biostable polyurethane derived from MDI, polycarbonatediol and 1,4-butanediol [3].

Potential Biomedical Applications

- Tissue adhesives and sealants
- Adhesion prevention barrier
- Absorbable scaffolds for tissue engineering
- Absorbable coatings
- Controlled release of drugs

For further information about the absorbable polyurethanes, please contact Dr Rao Bezwada, President, Bezwada Biomedical LLC, 15-1 Ilene Court, Hillsborough NJ 08844 at *rao@bezwadabiomedical.com* or visit *www.bezwadabiomedical.com*.

References

1. Rao S Bezwada; US Patent Application Publication No. 2006/0188547 A1
2. Rao S Bezwada; ACS PMSE Preprint 2006, 95, 1054
3. Bioresorbable Polyurethanes with Degradable Hard Segments, Poster 616,Society for Biomaterials Annual Meeting 2009