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Biocompatibility enhanced Waterborne Polyurethane based on a Castor oil

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Abstract

We proposed a new synthesis of enhancing the biocompatibility of waterborne polyurethanes (B-WPUs) for biobinding agent applications. This synthesis study of polyurethane dispersion based on polycaprolactone diol (PCL) and 4,4'-Methylene dicyclohexyl diisocyanate (H_{12}MDI) as soft segment of prepolymer, dimethylolbutanoic acid (DMBA) as emulsifier, and trimethylamine (TEA) as neutralizer, ethylenediamine (EDA) as chain extender, was to investigate the influence of different molecular weight of prepolymer or polyol. Mechanical properties (hardness, strength, elastic rate, abrasion resistance) of the adhesive itself are adapted to the living tissue. Also, the hardening agent does not physically stimulate or impair the biological tissue. Various properties to apply as bio-adhesives were studied through FT-IR, DSC, TGA, and UTM. Bio-adhesive is vital for biocompatibility. Biodegradation efficiencies by natural enzyme were also evaluated using degrading-enzyme systems, as a function of time. B-WPUs could be considered as a promising candidate to be applied the various bio-fields where biodegradation is important.

Objective

- To synthesize the biocompatible waterborne polyurethanes through two-step processing (basic WPU chemically bonded with the castor oil)
- To evaluate the castor oil effect on the mechanical properties of B-WPUs
- To investigate adhesion properties and the enzymatic biodegradability on the surface of collagen

Experimental

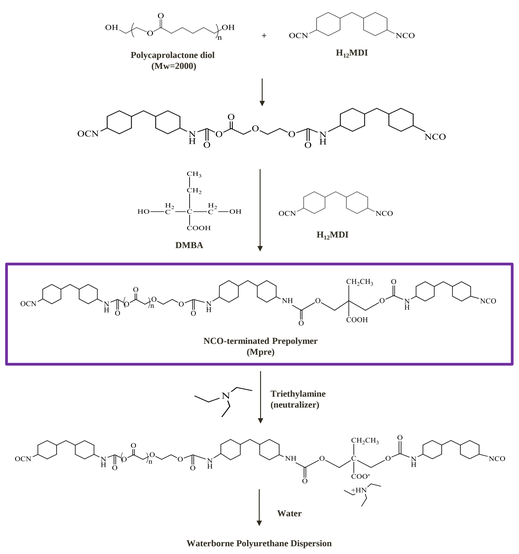
Formulation

(unit:mol)

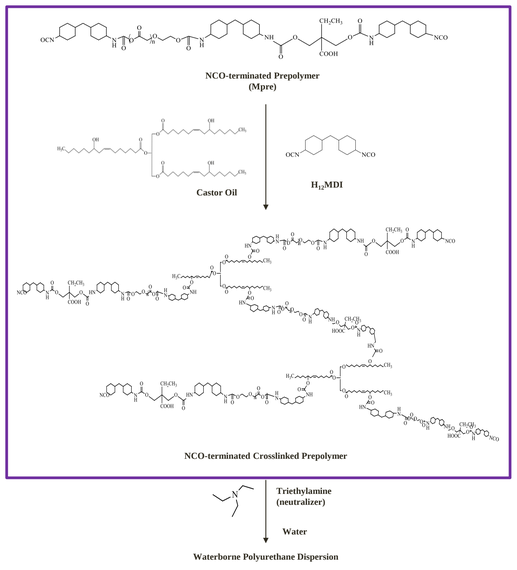
	Mpre	Series	Soft segment		Ionic group		Castor Oil		TEA
			PCL(530)	H_{12}MDI	DMBA	H_{12}MDI	Castor Oil	H_{12}MDI	
#1	3000	WPU-3	0.0293	0.0393	0.0101	0.0101	-	-	0.0101
#2		WPU-3C	0.0293	0.0393	0.0101	0.0101	0.0050	0.0050	0.0101
#3	6000	WPU-6	0.0310	0.0360	0.0101	0.0101	-	-	0.0101
#4		WPU-6C	0.0310	0.0360	0.0101	0.0101	0.0025	0.0025	0.0101
#5	10000	WPU-10	0.0316	0.0346	0.0101	0.0101	-	-	0.0101
#6		WPU-10C	0.0316	0.0346	0.0101	0.0101	0.0015	0.0015	0.0101
#7	30000	WPU-30	0.0323	0.0333	0.0101	0.0101	-	-	0.0101
#8		WPU-30C	0.0323	0.0333	0.0101	0.0101	0.0005	0.0005	0.0101

Solid:30g, Ionic group:5wt%

Scheme 1

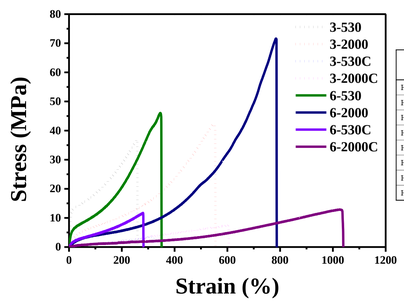


Scheme 2



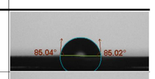
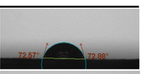
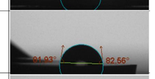
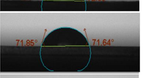
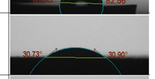
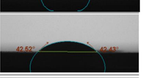
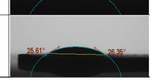
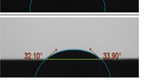
Results

Mechanical property of WPUs

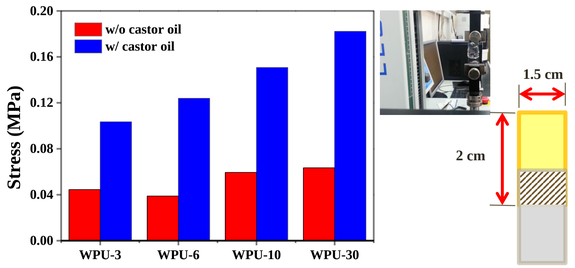


	PU Code	Young's Modulus (MPa)	Stress at break (MPa)	Elongation at break (%)
H1	3-530	194.91	36.77	255.69
H2	3-2000	23.24	41.81	551.11
H3	3-530-C	0.80	3.54	319.86
H4	3-2000-C	1.38	2.02	124.86
H5	6-530	75.67	46.02	346.94
H6	6-2000	8.16	15.51	529.44
H7	6-530-C	5.79	11.53	278.61
H8	6-2000-C	0.72	12.58	1034.86

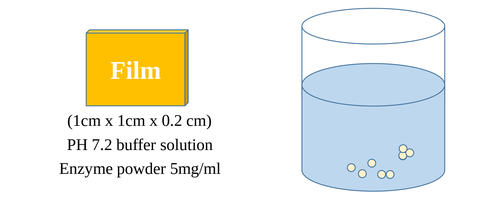
Contact Angle Test of WPUs

	Series	Mean(°)			Series	Mean(°)	
H1	3-530	85.02		H5	6-530	72.73	
H2	3-2000	82.20		H6	6-2000	71.75	
H3	3-530-C	30.82		H7	6-530-C	42.48	
H4	3-2000-C	25.98		H8	6-2000-C	33	

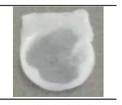
Adhesion Tests of B-WPUs



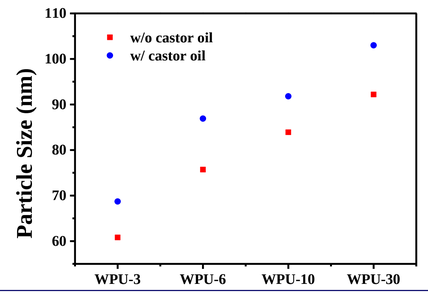
Enzymatic Degradation Test

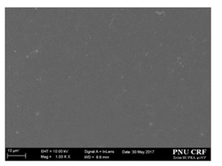


(after 2week)

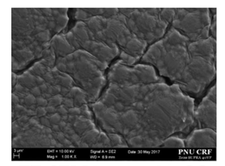
WPU-3	WPU-6	WPU-10	WPU-30
			
WPU-3C	**WPU-6C**	**WPU-10C**	**WPU-30C**
			

Particle Size of B-WPUs





FE-SEM image without CO



FE-SEM image with CO

Conclusion

- A molecular weight series of Castor oil-based B-WPU were successfully controlled
- Mechanical properties can be adjusted to suit particular wound closure

Acknowledgement

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