

List of Tables

Table 1.01	Uses of PU Depending Upon the Properties of the End Product
Table 1.02:	Comparison of Advantages of Polyurethane with Conventional Materials
Table 2.01	Average Composition of Castor Seed Oil/Fatty Acid Chains.
Table 5.01	List of Chemical Used for Experiment.

List of figures

Figure 1.00	Application for Polyurethane
Figure 1.01	Physical Properties of PU
Figure 2.00	General Structure of Polyurethanes
Figure 2.01	Commonly Used Di-isocyanates
Figure 2.02	Structure of Ricinoleic Acid
Figure 2.03	Structures of Organic Acid Catalysts
Figure 2.04	Proposed Scale for Structure Activity Relationship
Figure 2.05	Structures of Seven Membered Cyclic Carbonates
Figure 2.06	Plausible Mechanism for TBD/LiOTf Catalyzed Synthesis of Polyurethane
Figure 3.01	Comparison of (a) H¹ NMR and (b) FT-IR of Epoxide and Cyclic-Carbonate
Figure 3.02	(a) H¹-NMR and (b) FTIR Spectra of Epoxide and Cyclic-Carbonates
Figure 3.03	Comparative Study of FT-IR Spectroscopy
Figure 3.04	FT-IR Spectra of Epoxide and Dicyclic-Carbonate
Figure 3.05	¹H NMR Spectra of Epoxide and Dicyclic-Carbonate
Figure 5.01	¹HNMR Spectrum of Crude Glycerol Carbonate
Figure 5.02	FT-IR Spectrum of Crude Glycerol Carbonate
Figure 5.03	¹HNMR Spectrum of Bis-Glycerol Carbonate Monomer
Figure 5.04	FT-IR Spectrum of Bis-Glycerol Carbonate Monomer

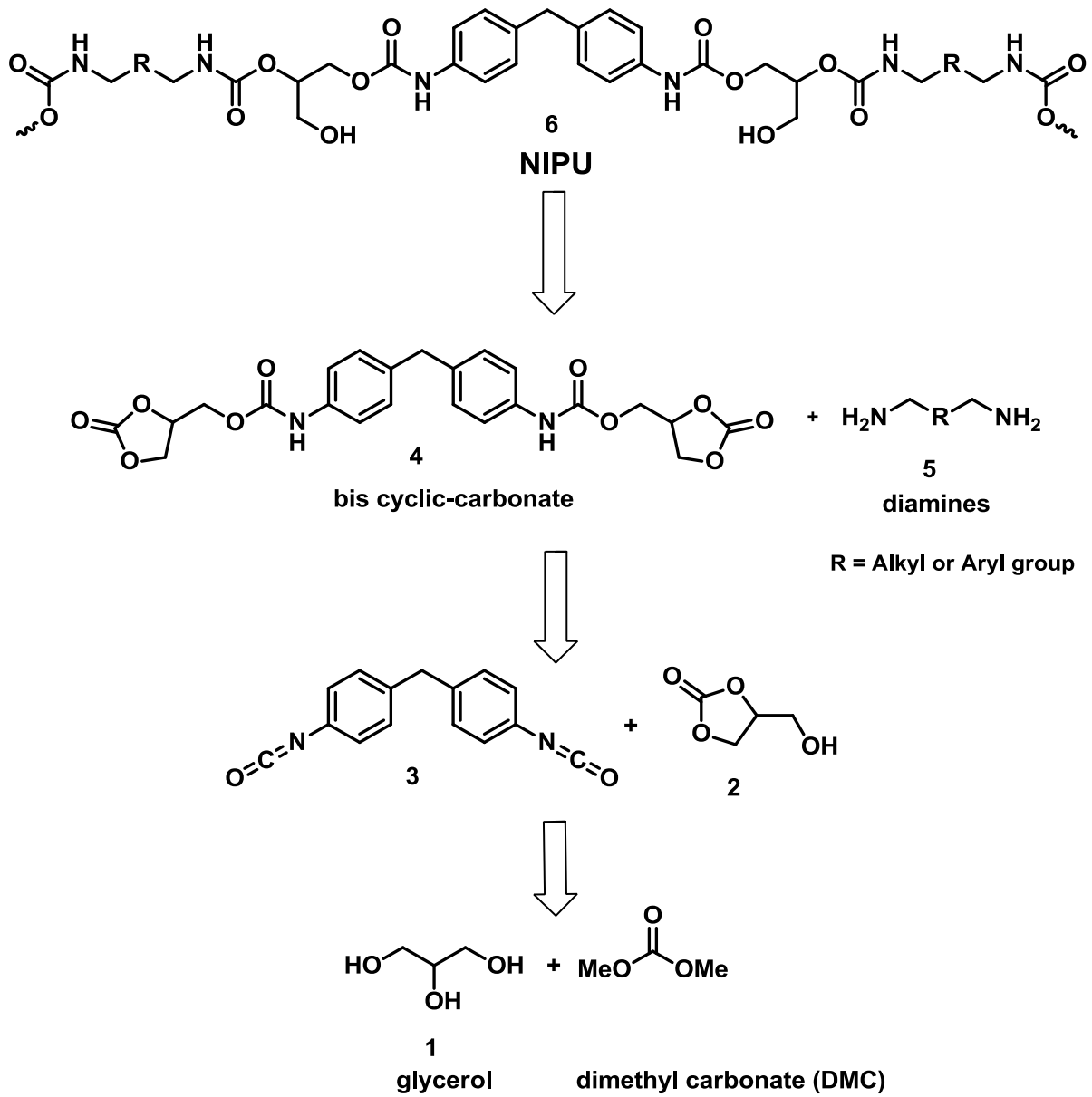
List of Scheme

Scheme 2.1	Possible Reactions of Isocyanate
Scheme 2.2	Plausible Mechanism of Urethane Formation
Scheme 2.3	Plausible mechanism of PU
Scheme 2.4	Organotin complex catalyzed urethane formation
Scheme 2.5	N-Heterocycle Carbene Catalysed Urethane Formation
Scheme 2.6	Organic Acid Catalyzed O-activated Polyurethane Formation
Scheme 2.7	Organic Acid Catalyzed N-activated Urethane Formation
Scheme 2.8	Interaction of Lewis Acid with Isocyanate Group
Scheme 2.9	Plausible Mechanism for Formation Polyurethane Under Photochemical Condition.
Scheme 2.10	Blowing Reaction of Isocyanate
Scheme 2.11	Phosphene Catalyzed Dimerization Reaction
Scheme 2.12	Isocyanate Trimerization Reaction
Scheme 2.13	Polyurethane from Dicyclic Carbonate and Diamines
Scheme 2.14	Mechanism for NIPU Synthesis
Scheme 2.15	Ring Opening Metathesis for Urethane Formation
Scheme 2.16	TBD/LiOTf Catalyzed Formation of Polyurethane
Scheme 2.17	The Chemical Degradation of PU
Scheme 3.1	Synthesis of Cyclic-Carbonates from Epoxide Functionalized Oils
Scheme 3.2	Synthesis of NIPU from Terpene Derivatives
Scheme 3.3	Iron Complex Catalyzed Synthesis of Bis Cyclo-Carbonate
Scheme 3.4	Synthesis of Cyclo-Carbonates by Phosgenation of Diols
Scheme 3.5	Synthesis of Cyclo-Carbonate by the Insertion of CO₂ into Oxirane
Scheme 3.6	Synthesis of Cyclo-Carbonate from Halohydrin
Scheme 3.7	Synthesis of Cyclic Carbonate
Scheme 3.8	Cyclic Carbonate from Propargyl Alcohols
Scheme 3.9	Approach for synthesis
Scheme 5.1	Retrosynthetic Analysis of NIPU from Glycerol Carbonate
Scheme 5.2	Synthesis of Bis-Glycerol Carbonate Monomer (4)
Scheme 5.3	Synthesis of Various Non-isocyanate Polyurethanes (NIPUs)

Abbreviation

BASF	Badische Anilin- und Soda-Fabrik
CFC's	Chlorofluorocarbons
DABCO	1,4-diazabicyclo[2.2.2]octane
DBU	1,8-Diazabicyclo[5.4.0]undec-7-ene
DMCHA	N, N-Dimethylcyclohexylamine
DMEA	Dimethylethanolamine
EDI	Diphenylethane diisocyanate
FPF	Flexible polyurethane foam
FT-IR	Fourier transform infrared spectroscopy
GO	Graphene oxide
HDI	Hexamethylene diisocyanate
HCFC	Hydro chlorofluorocarbons
IPDI	Isophorone diisocyanate
LiOTf	Lithium triflate
MDI	Methylene diphenyl diisocyanate
MPa	Mega Pascal
NBR	Nitrile Rubber
NIPU	Non isocyanate polyurethane
PPF	Poly(propylene fumarate)
PU	Polyurethane
PVC	Polyvinyl Chloride
PS	Polystyrene
RIM	Reaction injection molding
SBR	Styrene-butadiene rubber
TBAB	Tetrabutylammonium bromide

Graphical Abstract



ABSTRACT

Polyurethanes are the versatile, responsive and long-lasting fabricated material that can replace paints, cotton, rubber, metal or wood in various applications across all fields such as packaging, decorative goods, foam, adhesives, engineering plastic and biomedical applications etc. Polyurethanes are generally synthesized by reacting di-isocyanates with diols resulting in urethane linkages. There are some challenges of isocyanate polyurethane as the raw materials used MDI and TDI are hazardous for health and environment. The exposure to isocyanate causes irritation of skin and mucous membranes, chest tightness, and difficulty in breathing. Isocyanates compounds are carcinogens and are reported to cause cancer. The present studies has been carried out to synthesize a novel monomer bis((2-oxo-1,3-dioxolan-4-yl)methyl) (methylene bis(4,1-phenylene)) dicarbamate for the preparation of Non Isocyanate Polyurethane (NIPU), which is environment friendly. For this purpose glycerol is used as the main raw material. Glycerol is generally produced as a byproduct of various industries. The huge availability and biocompatibility of glycerol makes it a readily available material. So we have been attracted to utilize this huge available material for a better mankind application. In this research work, we had developed a novel glycerol based monomer: bis((2-oxo-1,3-dioxolan-4-yl)methyl) (methylene bis(4,1-phenylene)) dicarbamate. This monomer was reacted with various diamines and is used for NIPU synthesis. The formation of Polyurethane was confirmed by FT-IR spectroscopy.

Key Words: Polyurethane, MDI, TDI, Glycerol, NIPU etc.