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Fabrication of 3D printing material based on the relationship between viscosity and molecular weight of Polyurethane and UV curing time

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Abstract

The intrinsic viscosity of the photo-curable monomer and polymer is measured to target the molecular weight of the material. The photo-curing polymer is produced through physical or chemical reaction, and the curing time and physical properties of the material are adjusted according to the purpose. It can be controlled the ratio of the photo initiator and urethane. For example, Thermoplastic polyurethane (TPU) series based on poly(tetramethylene glycol) (PTMG1000) as a polyol and methylene diphenyl diisocyanate (MDI) as a isocyanate were synthesized as a function of molecular weight formulation. After that, it is photo-cured by attaching acrylate, and it is designed by applying UV through hydrogel type 3D printing.

Objective

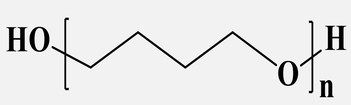
1. To synthesize a PU-Acrylate products composed of PTMG as a polyol and MDI as an isocyanate and acrylate content
2. To evaluate the physical properties and reduce the contents of isocyanate of PU-Acrylate
3. To compare the viscosity of PU-Acrylate

Synthesize of Polyurethane with Acrylate

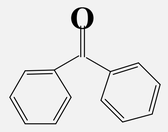
- High mechanical properties compared to the conventional
- Reduce the photo-curing time used by acrylate ratio
- Apply to future 3D Printer due to viscosity control

Materials

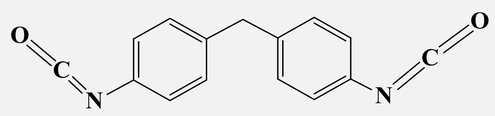
PTMG 1000



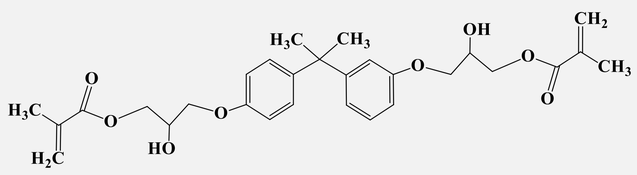
Benzophenone



MDI(Methylene diphenyl diisocyanate)



BisGMA(Bisphenol A Glycerolate dimethacrylate)



Experimental

SCHEME

Step 1 Poly(tetramethylene glycol)1000 + MDI(methylene diphenyl diisocyanate)

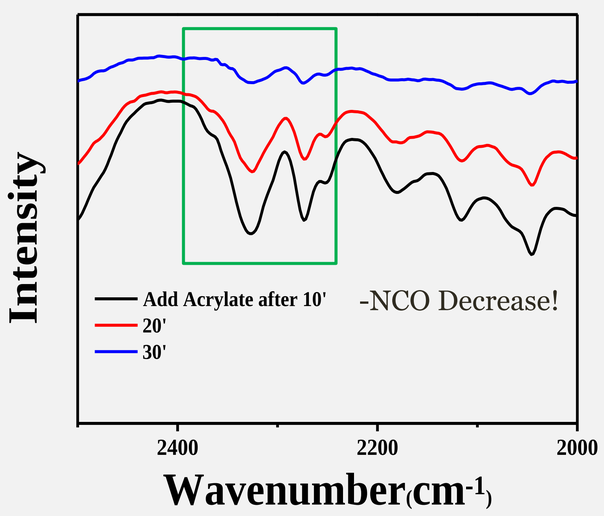
Step 2 Addition of bis GMA

Step 3 Addition of MDI for hard segment

Step 4 Addition of Benzophenone

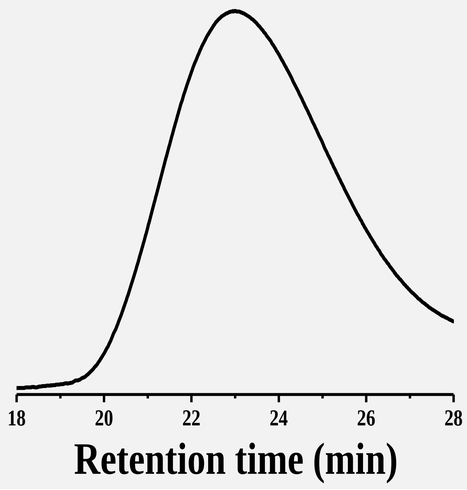
Results

FT-IR



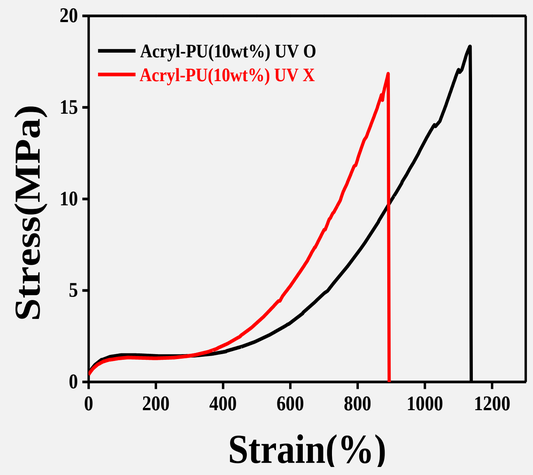
Characterization peak	Wave length(cm^{-1})
-NCO(Isocyanate)	2270

GPC



$\bar{M}_n$	$\bar{M}_w$	Polydispersity
13915	23761	1.707570

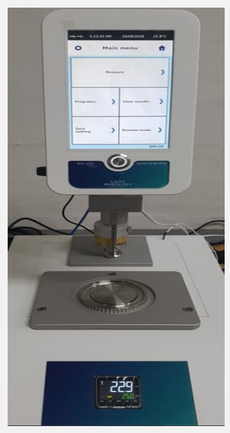
UTM



	Young's Modulus (Mpa)	Maximum Stress (Mpa)	Percent Strain(%)
UV O	5.2868	18.335	1135.3
UV X	7.4429	16.869	891.3

VISCOSITY

SAMPLE	VISCOSITY
PU-ACRYL	2348mPa.s
PHOTO INITIATOR 1wt%	2850mPa.s
PHOTO INITIATOR 5wt%	6591mPa.s
PHOTO INITIATOR 10wt%	7490mPa.s



CONDITION	
SHEAR RATE	$50s^{-1}$
DURATION	60sec

Conclusion

- The successful synthesis PU-Acrylate and UV-cured by the photo-initiator
- The mechanical properties(stress, strain) are increased by UV-curing (Stress : 16.869Mpa ⟶ 18.335Mpa, Strain : 819.3% ⟶ 1135.3%)
- Measure the suitable amount and viscosity of initiators for use in 3D printer

Acknowledgement

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