

# **Fabrication of Photo-Activating Acryl- polyurethane Through Short Curing Time**

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# Abstract

Photo-activating Acrylate polyurethane (Acryl-PU) is successfully synthesized by the additional reaction of methylene diphenyl diisocyanate (MDI), poly(tetramethylene ether) glycol, and tri-acrylate derivatives as a crosslinking point. The crosslinked Acryl-PU elastomers are created by the exposure of 200~400 $\mu\text{m}$  UV radiation. To order to reduce crosslinking time, THF with low UV cut off was used as a solvent for crosslinking the Acryl-PU. The structures and properties of the resulting Acryl-PUs were evaluated by fourier transform infrared spectroscopy (FT-IR), gel permeation chromatography (GPC), ultra violet spectroscopy (UV-Vis), differential scanning calorimetry (DSC), and universal testing machine (UTM). The increase of acrylate concentration in Acryl-PU elastomers leads higher tensile strength and hardness due to the increased crosslinking density and the enhanced interchain hydrogen bonding. The applicational potential as a 3D printing material is verified according to the shortened crosslinking time.

# 3D Print

- Definition: processes used to create a three-dimensional object in which layers of material are formed under computer control to create an object

- Materials of 3D printing

  - Plastics : Polyamide(PA), ABS, PLA, Thermoplastic Polyurethane etc.

  - Resins : CLIP, CE- Cyanate Ester, Prototyping Acrylate etc.

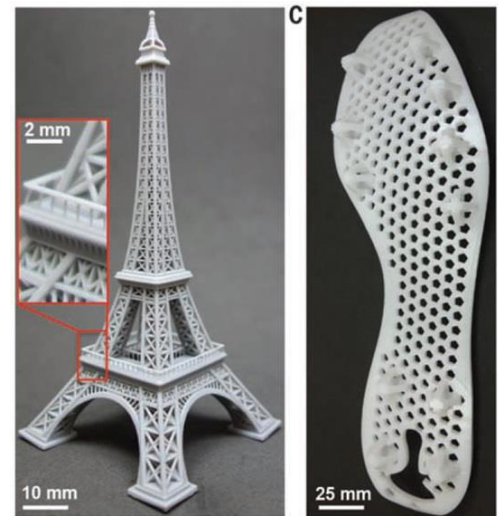
  - Multicolor(composite material)

  - Metals

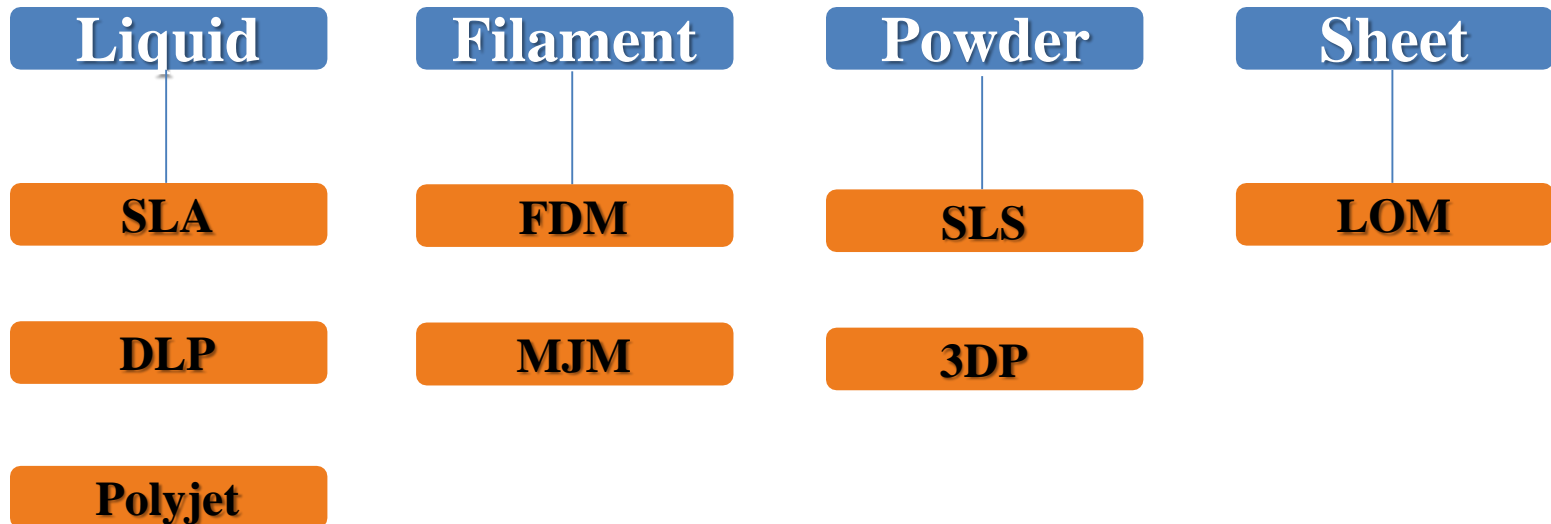
- Many Applications:

Medical - Bio-printing, Medical devices, Pills

Industry - Aerospace, Car's body, Architectures, Apparel etc.



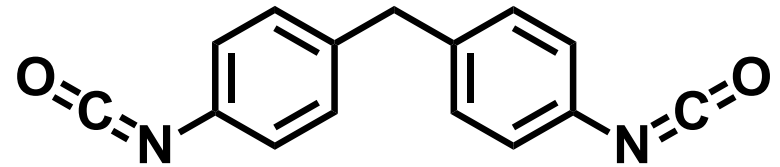
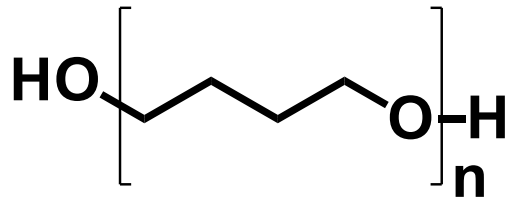
# Materials of 3D printing & classification according to output method



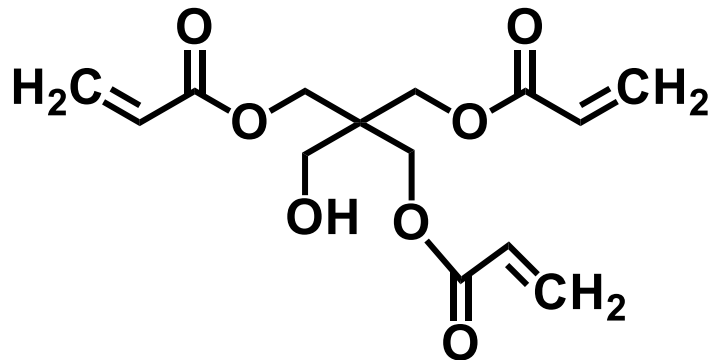
# Experimental

## Materials

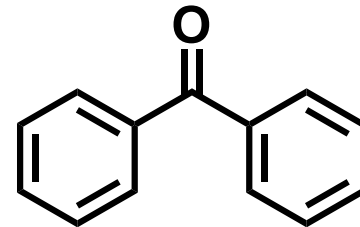
-Polyol : PTMG (poly(tetramethylene ether) glycol) -Isocyanate : MDI (methylene diphenyl diisocyanate)



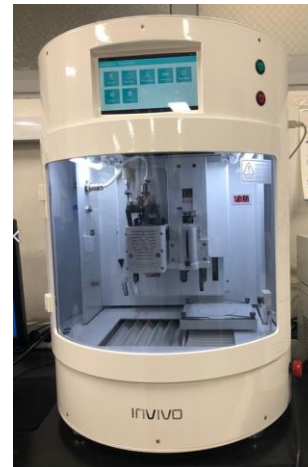
-Acrylate : Pentaerythritol triacrylate



-Photo initiator : Benzophenone



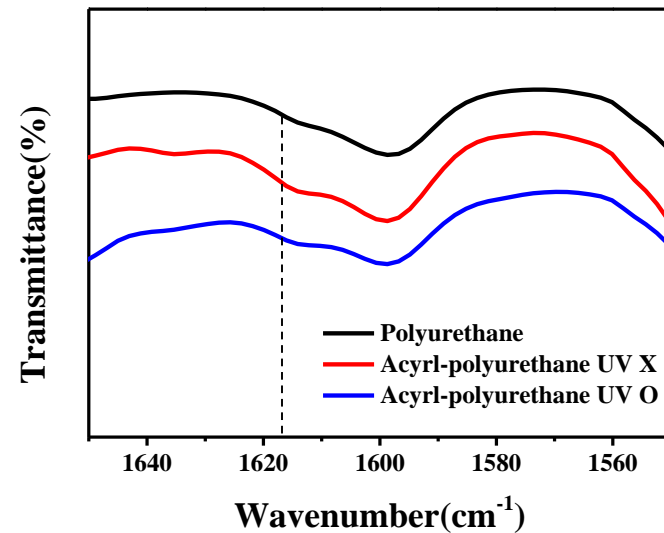
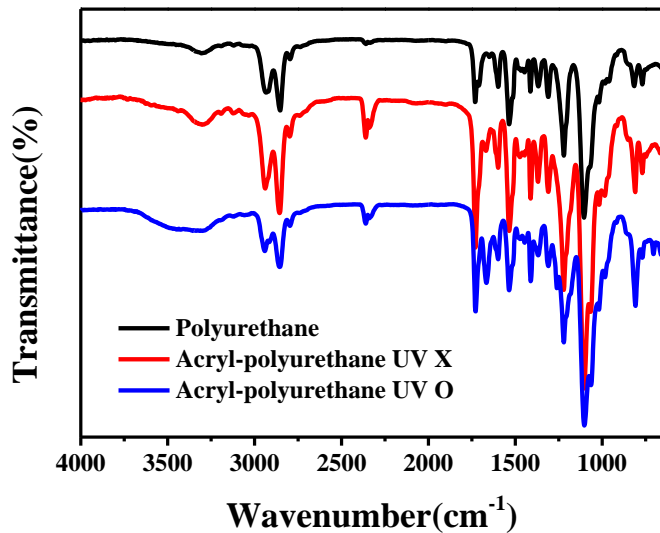
UV crosslinker





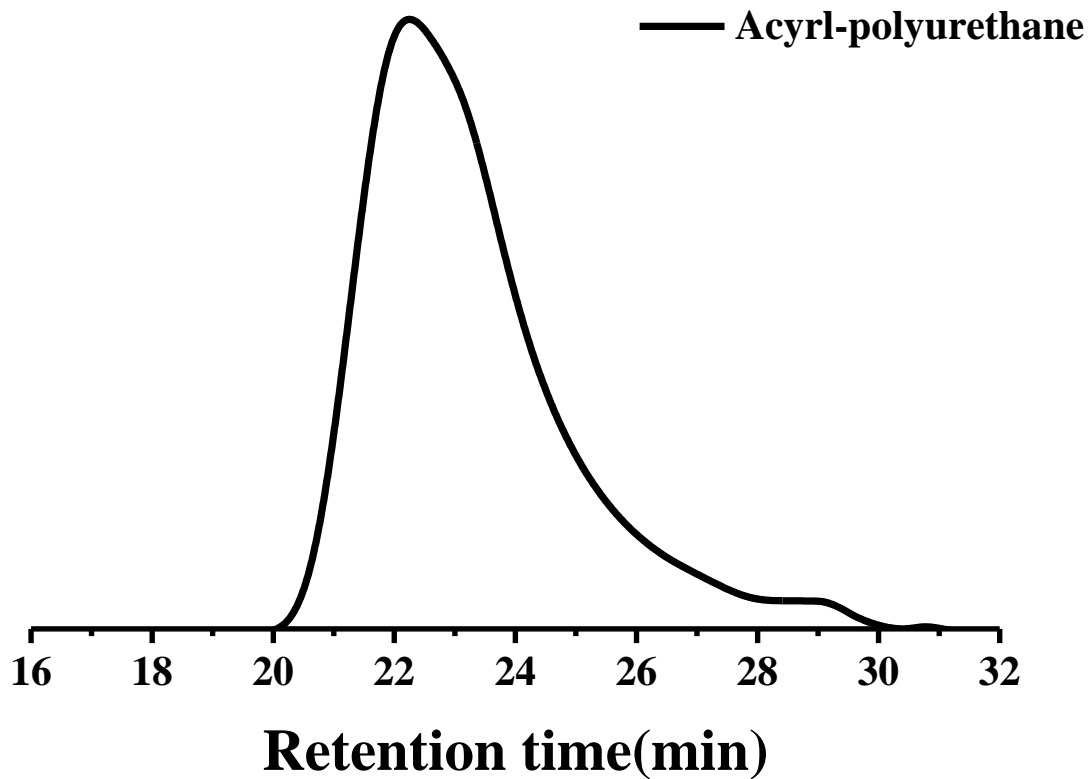
# Analysis of FT-IR

1. PU  $\rightarrow$  Acryl-polyurethane : Appear of functional peak CC double bond around  $1620\text{cm}^{-1}$
2. Before and After UV : Reduce of functional peak CC double bond around  $1620\text{cm}^{-1}$  and intermolecular crosslinked by UV-curing



# Analysis of GPC

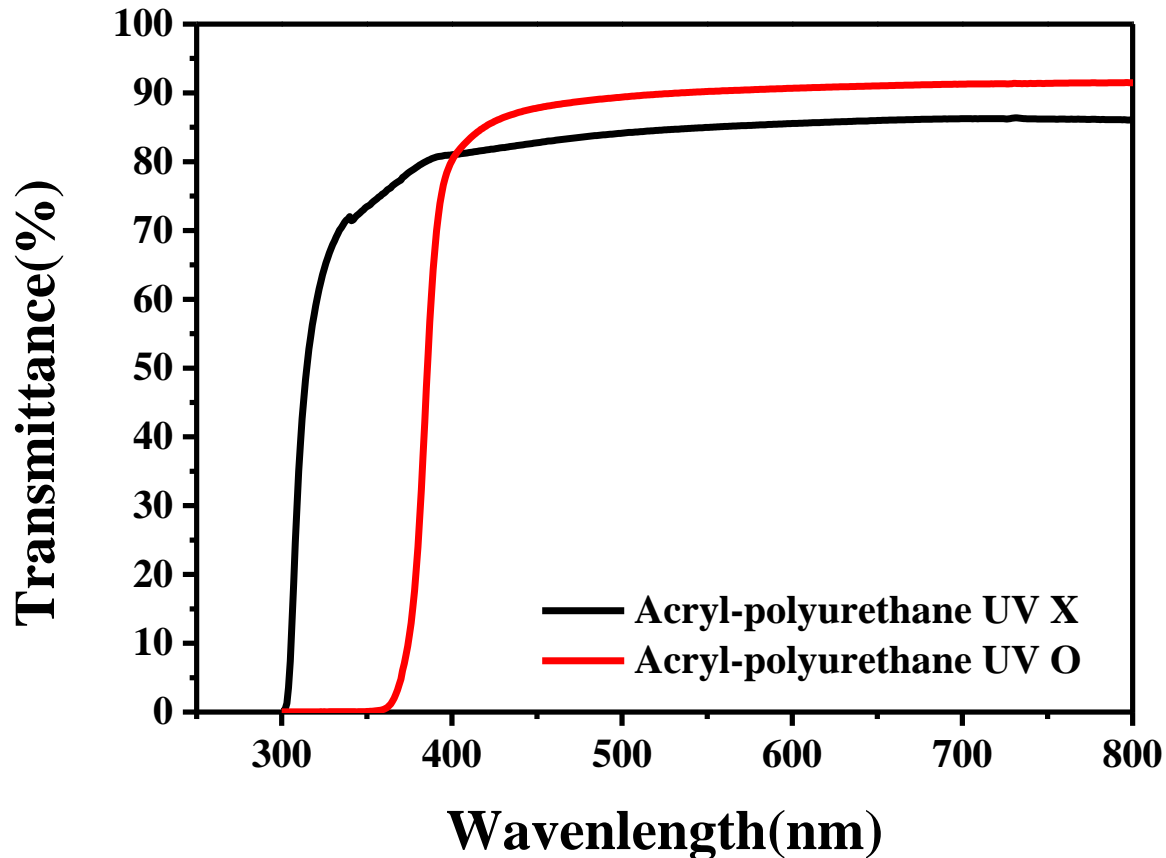
	$M_n$	$M_w$	PDI
Acryl-polyurethane	10200	27320	2.68





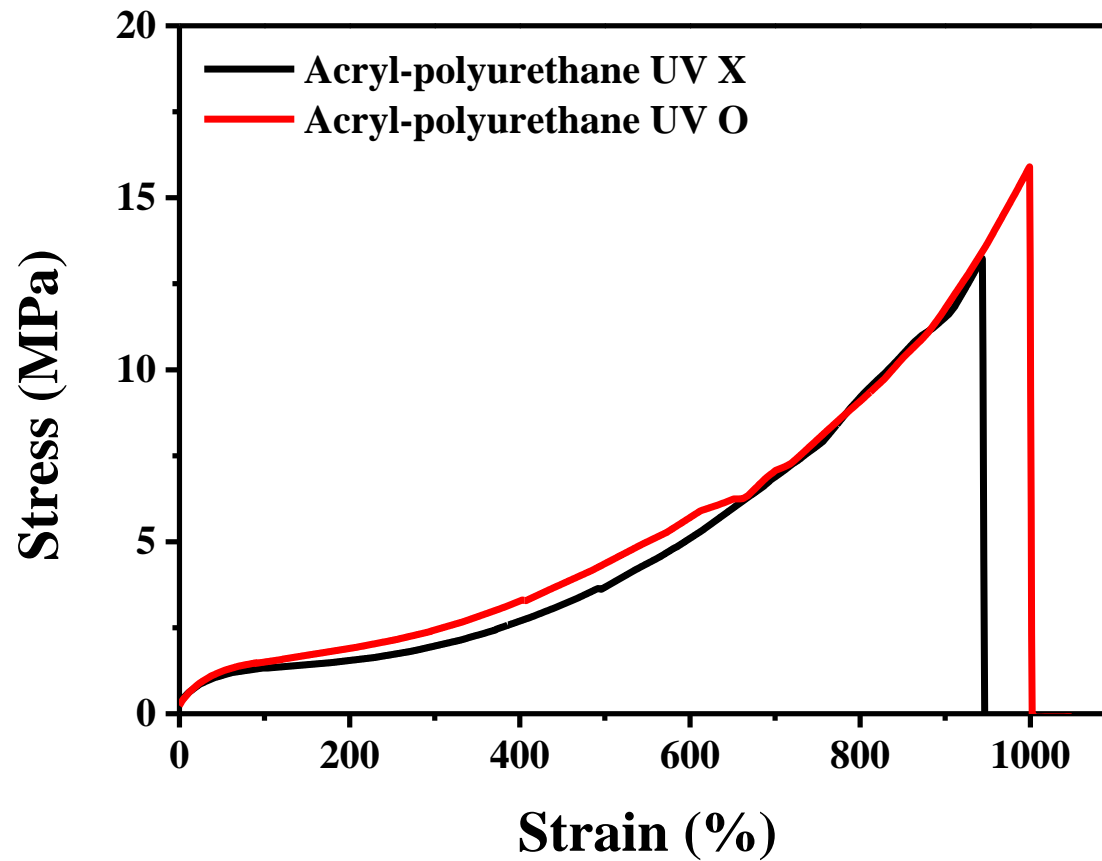
# Analysis of UV Transmittance

UV-Transmittance was increased at 550nm as the increasing amorphous parts after UV-curing



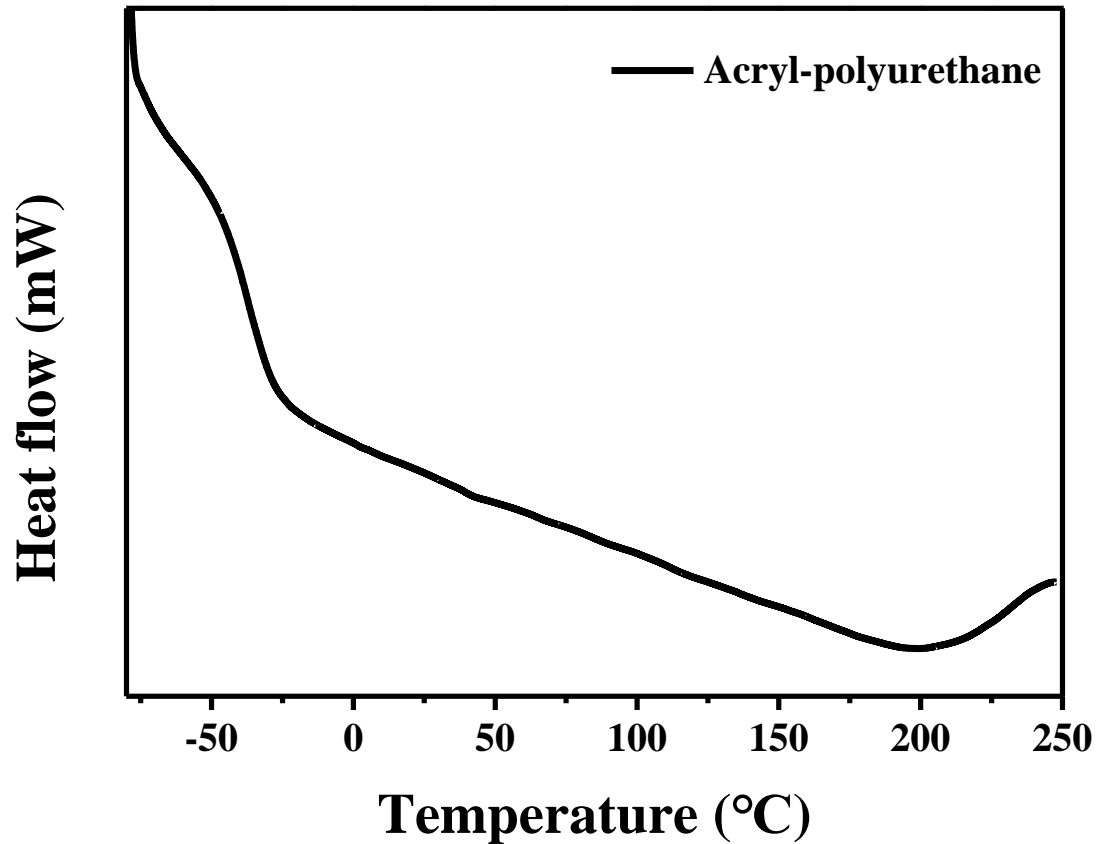
# Analysis of UTM

Increase of stress and strain after UV-curing



# Analysis of DSC

$T_g$  was measured  $-52^\circ\text{C}$ ,  $T_m$  was measured  $199^\circ\text{C}$



# Conclusions

- The successful synthesis Acryl-polyurethane and UV-cured by the photo-initiator
- The special optical properties of the Acryl-polyurethane after UV-curing  
(UV transmittance : 83 to 90%)
- The increase of percentage strain and tensile strength after UV-curing
- The thermal properties were measured using DSC  
( $T_g = -52^\circ\text{C}$ ,  $T_m = 199^\circ\text{C}$ )
- To demonstrate potential applications of 3D printer materials

# Acknowledgement

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