

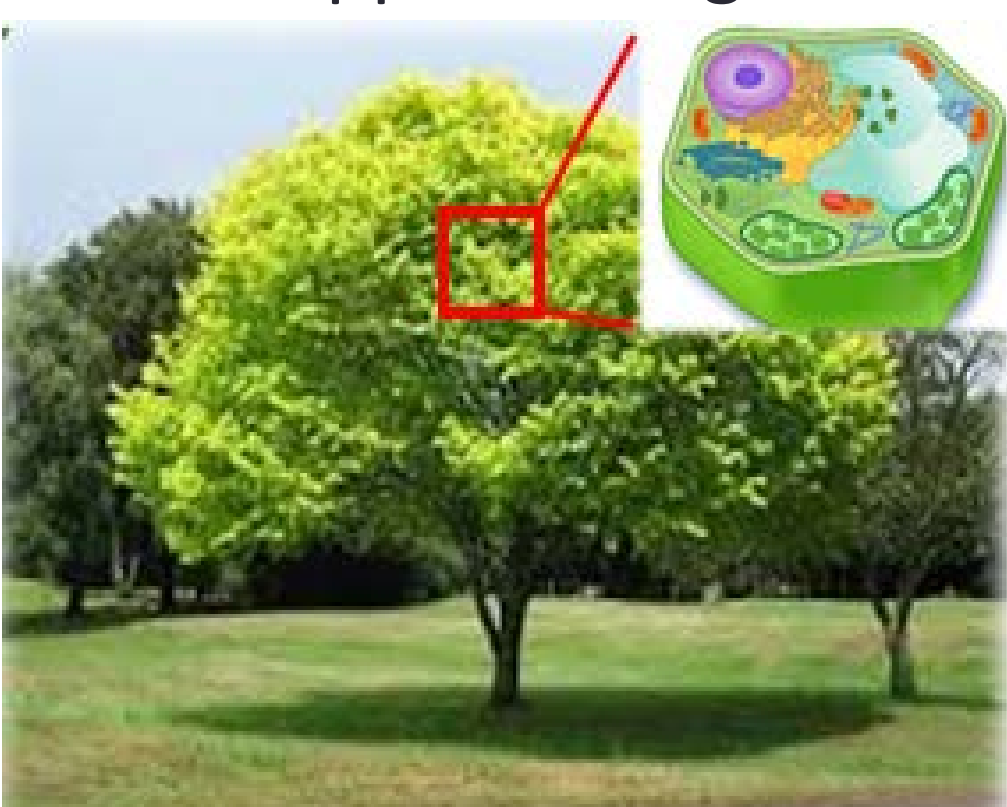
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## Introduction

- Hydrogels are known as polymeric networks which are commonly synthesized from petrochemicals. However, due to the increasing oil demand in recent years, lignin products are considered as substitutes for hydrogel synthesis.
- A number of publications dealing with lignin and hydrogel products have been examined. However, few resources discuss the potential efficiency and development of epoxy coating technology for hydrogel. Polymeric coated hydrogels are applied as agricultural nutrition support.



Reasons for choosing lignin:

- Abundant storage
- Biodegradable
- Low cost
- Rich in functional groups
- Improving in mechanical properties

## Objectives

- Develop a convenient and environmentally friendly method for hydrogel synthesis. Manipulate the coating application (temperature, methods, time) conditions to optimize maximum urea releasing ability of lignin based hydrogel via novel coating method. Conduct the releasing test of urea releasing rate.

## Experimental methods

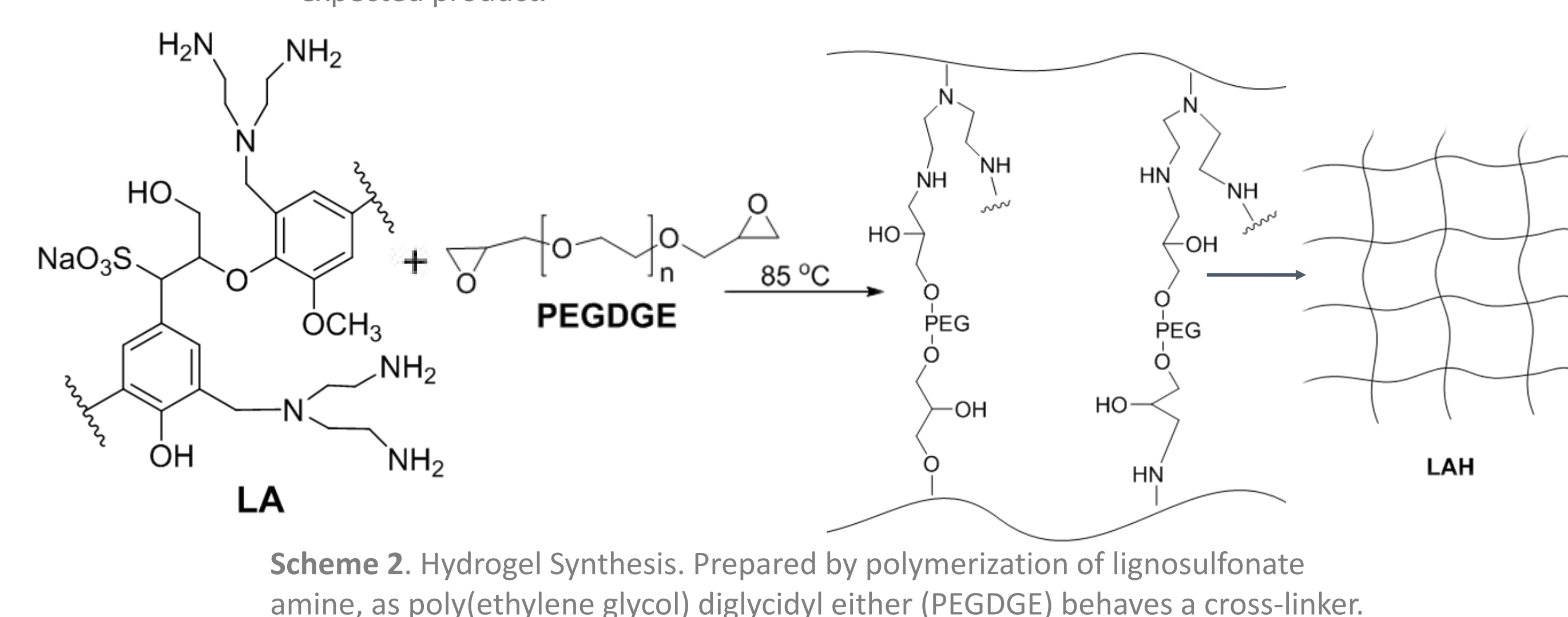
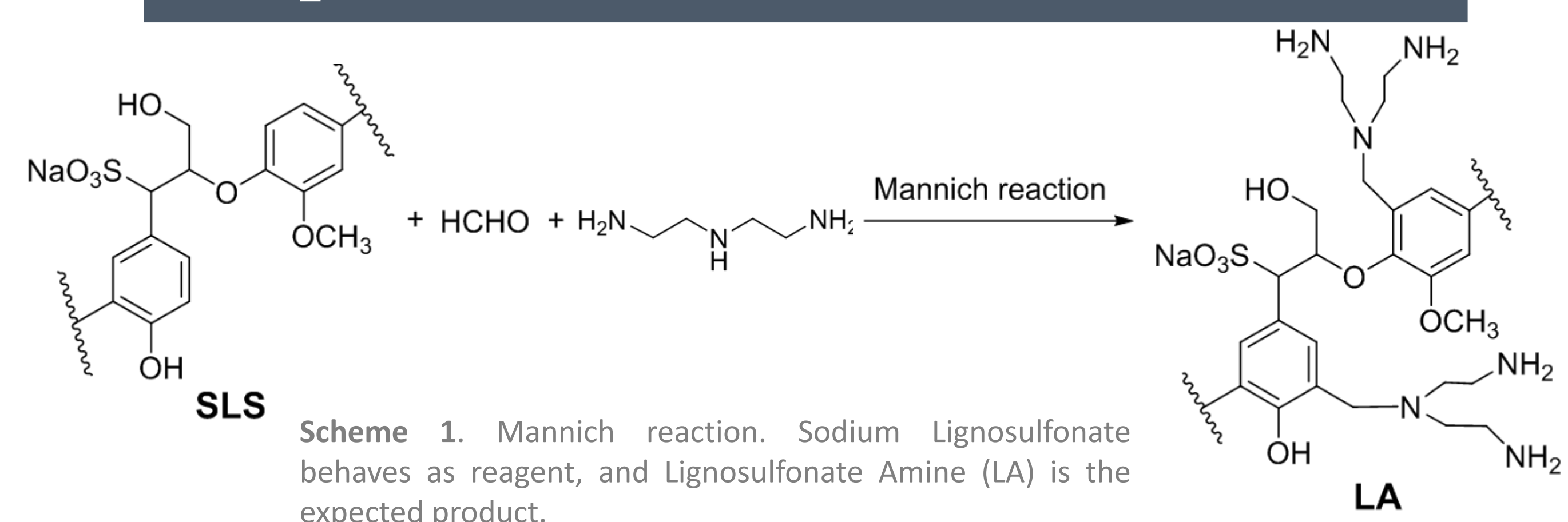
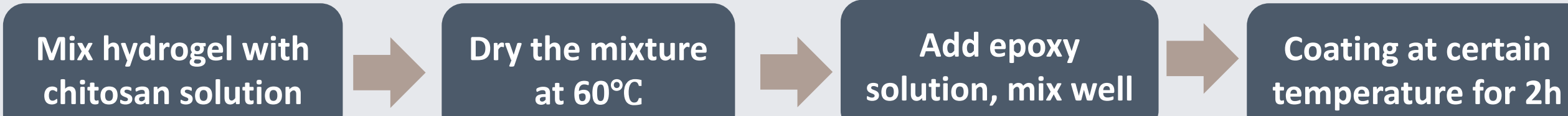


Figure 1. (a) Sodium Lignosulfonate (b) Lignosulfonate Amine (c) Lignin-based Hydrogel

### Solid-liquid Coating



### Liquid-liquid Coating



### Coating Method Flowchart

- Coated hydrogel sample was placed into a filtrate bag then submerged into 400 mL distilled water at room temperature. At each designated time interval, 20 mL solution was taken out, bottled, then refilled the container to 400mL total.



Figure 2. Releasing Test Setting

## Analytical results

### 1. Differential Scanning Calorimeter

- The non-isothermal DSC was used under a nitrogen atmosphere to test if the epoxy monomers could be successfully cured.

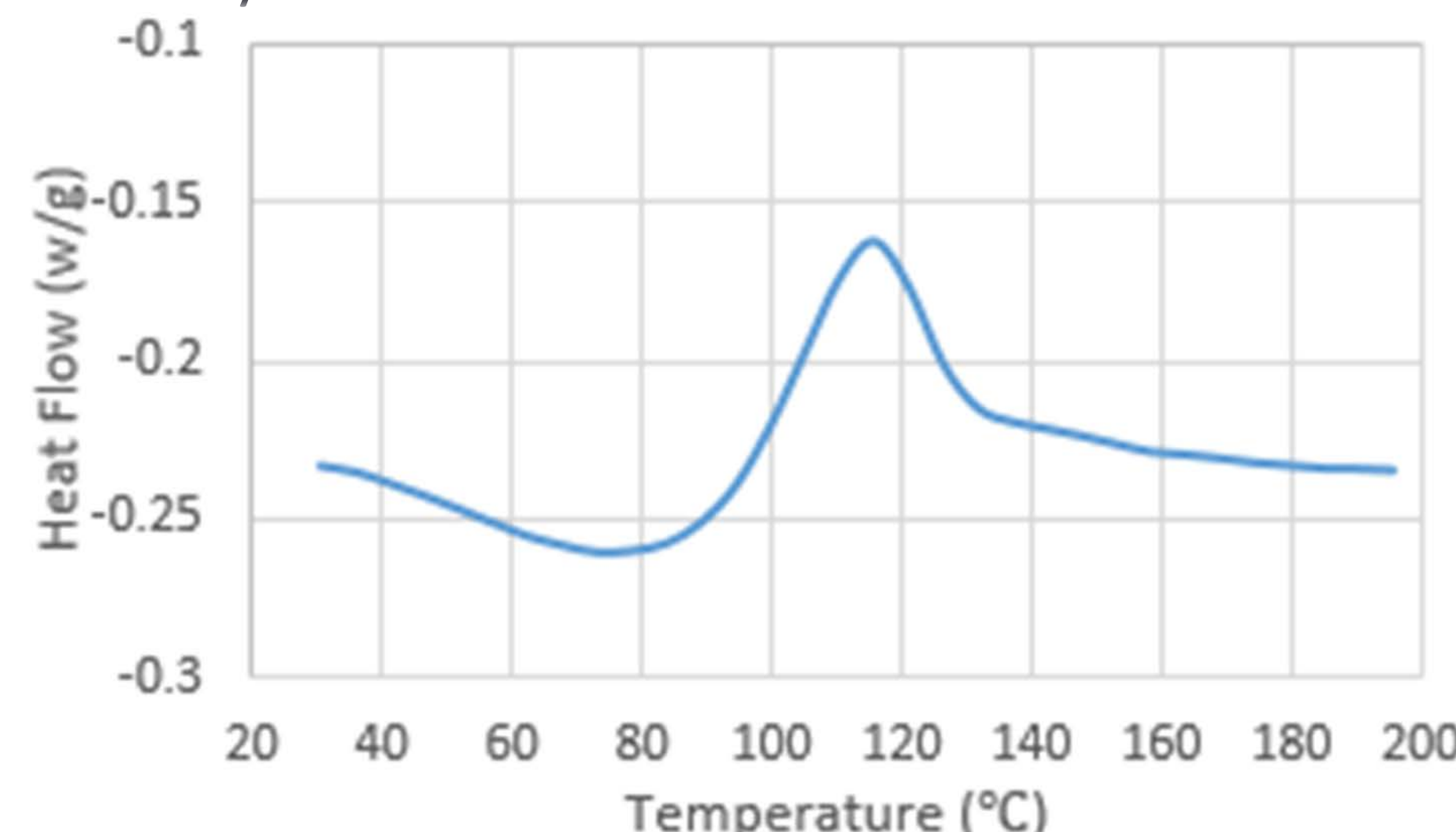


Figure 3. DSC curves for testing cured reaction between epoxy and chitosan.

- The obvious peak at 120 °C indicated that the epoxy monomers were cured completely under certain reaction conditions. The temperature condition for further coating should be above 120°C for better coating results which can be monitored via releasing test.

### 2. Fourier Transform Infrared Spectroscopy

- The completion of epoxy monomers curing was determined by employing FT-IR.

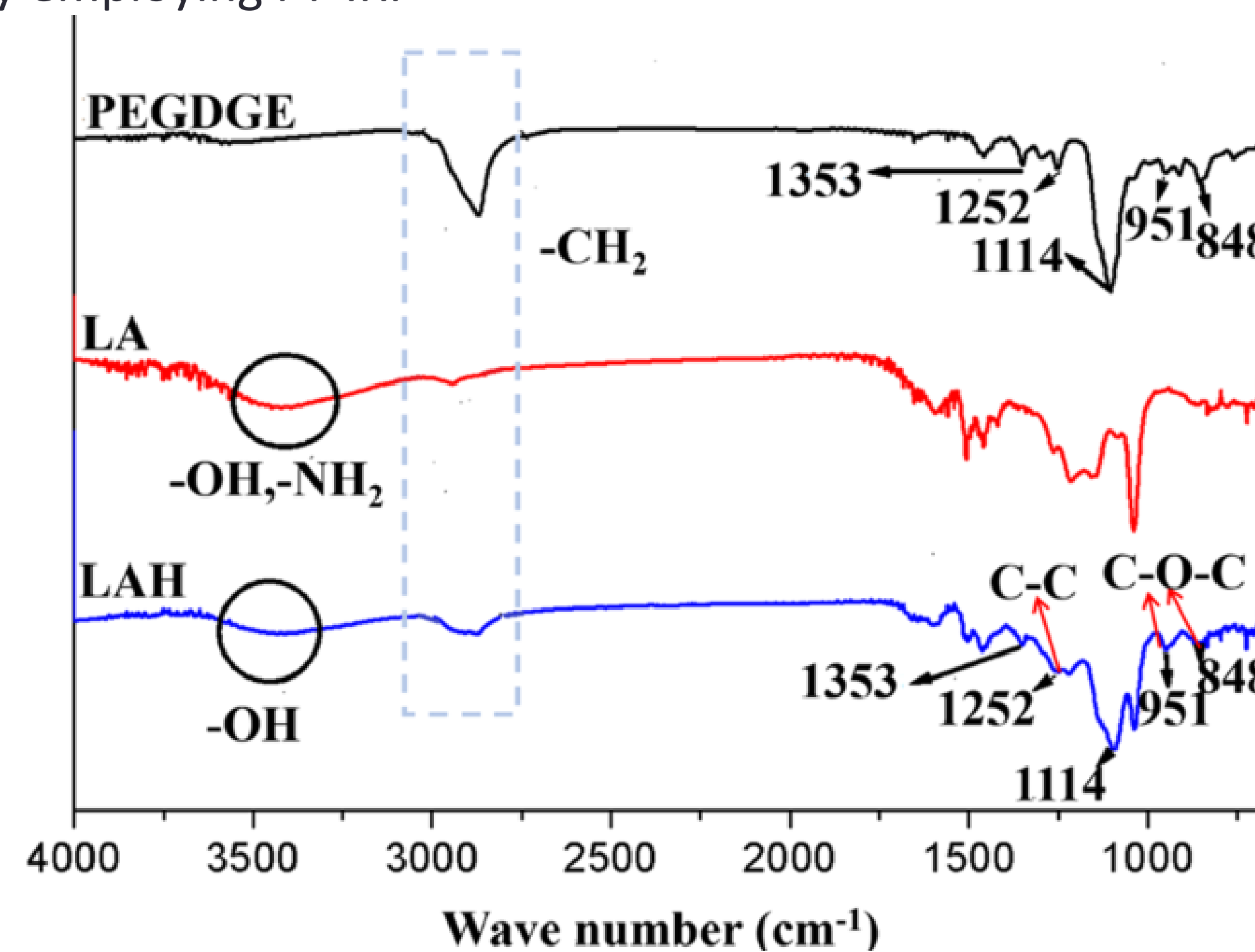


Figure 4. : FT-IR spectra of PEGDGE, LA, and LAH. PEGDGE and LA were reagents for epoxy monomer cured, with LAH as the product. Specific peaks were emphasized.

- Two bands in LAH at 1114 and 951  $\text{cm}^{-1}$ , which were attributed to the C-O-C stretching vibration, clearly indicated the presence of the PEGDGE segments in the hydrogel. The inclusion of the PEGDGE moiety in the hydrogel was also supported by the increased absorbance of bands from 2850 to 2910  $\text{cm}^{-1}$ , which were originated from the C-H stretching of methylene in PEGDGE. New bands at 1353 and 848  $\text{cm}^{-1}$  corresponded to the C-H bending vibration and 1252  $\text{cm}^{-1}$  was attributed to the C-C stretching.

### 3. Ultra-violet

- 4-dimethylaminobenzaldehyde was used as color development reagent.

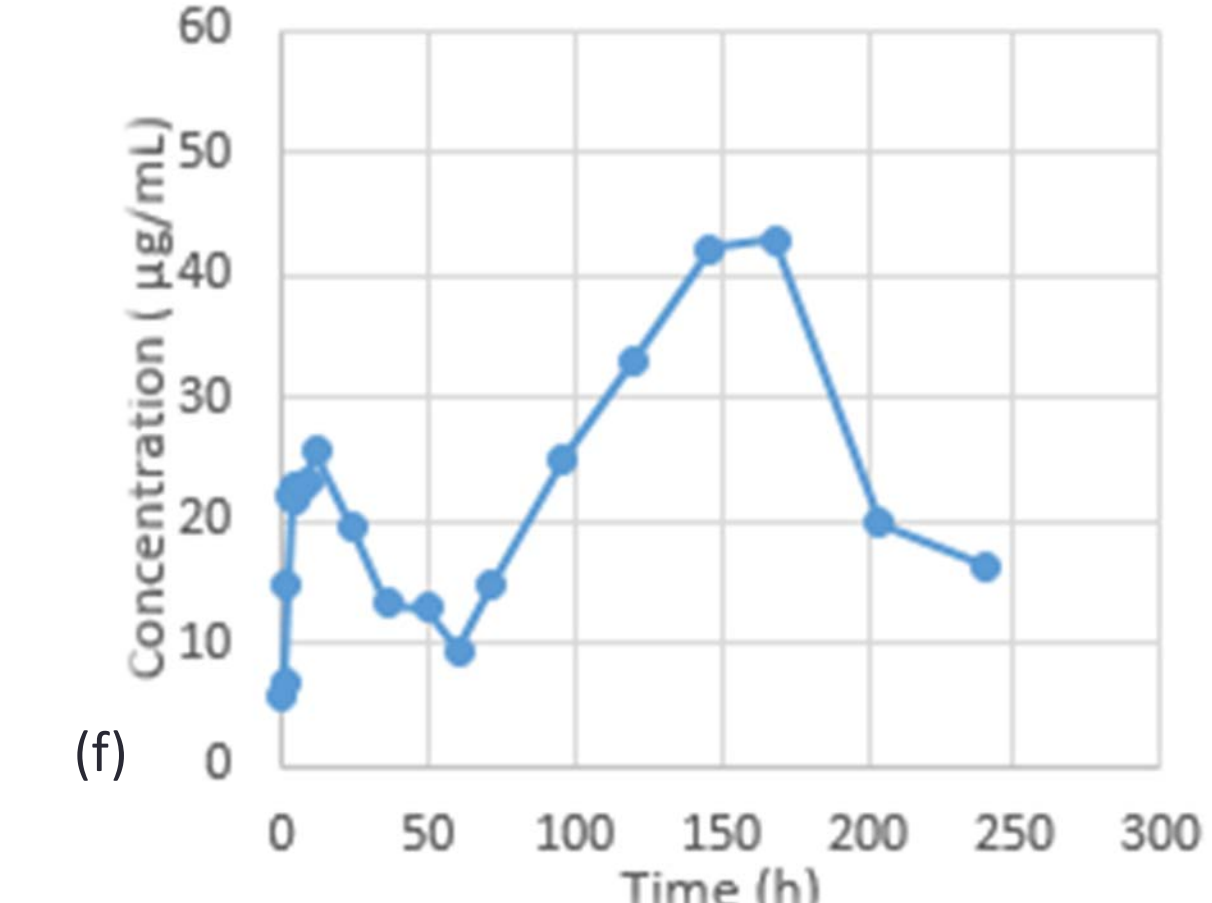
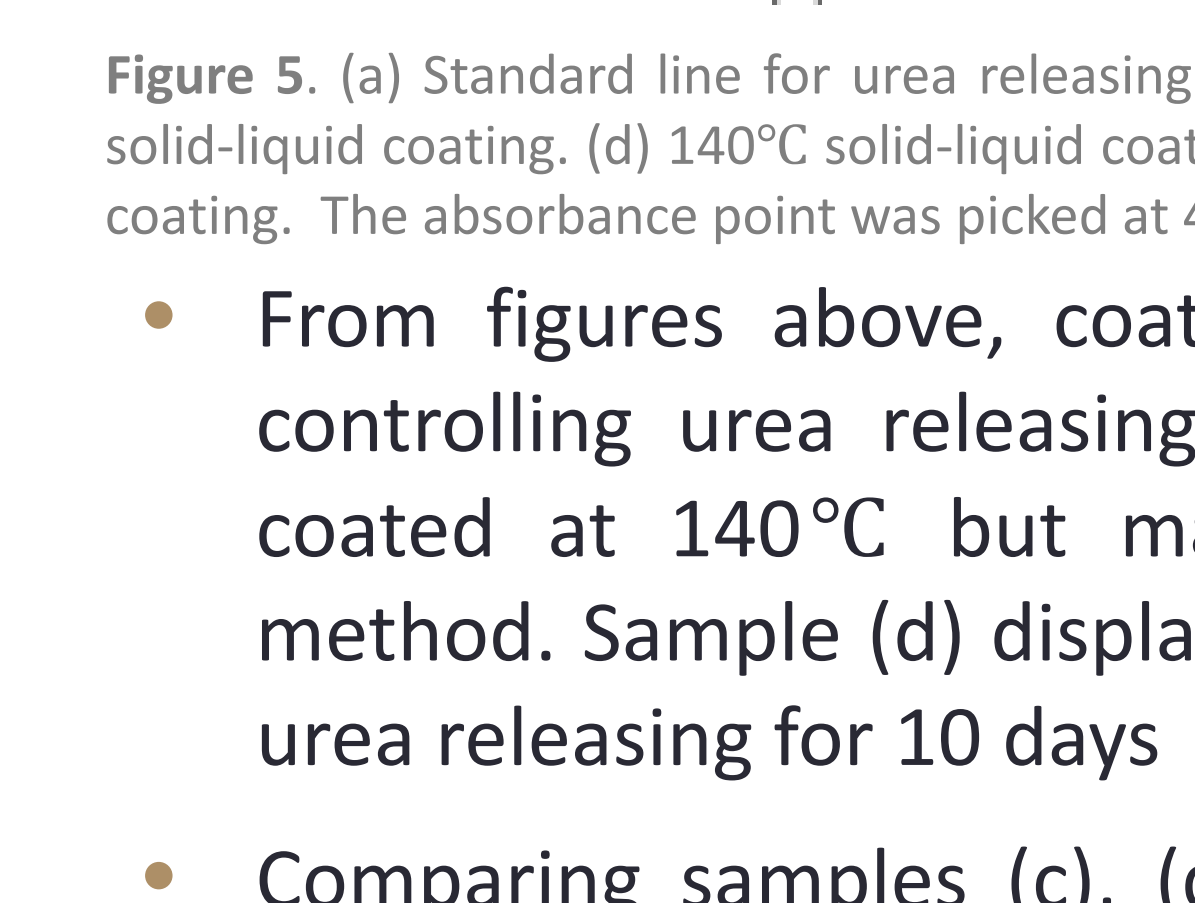
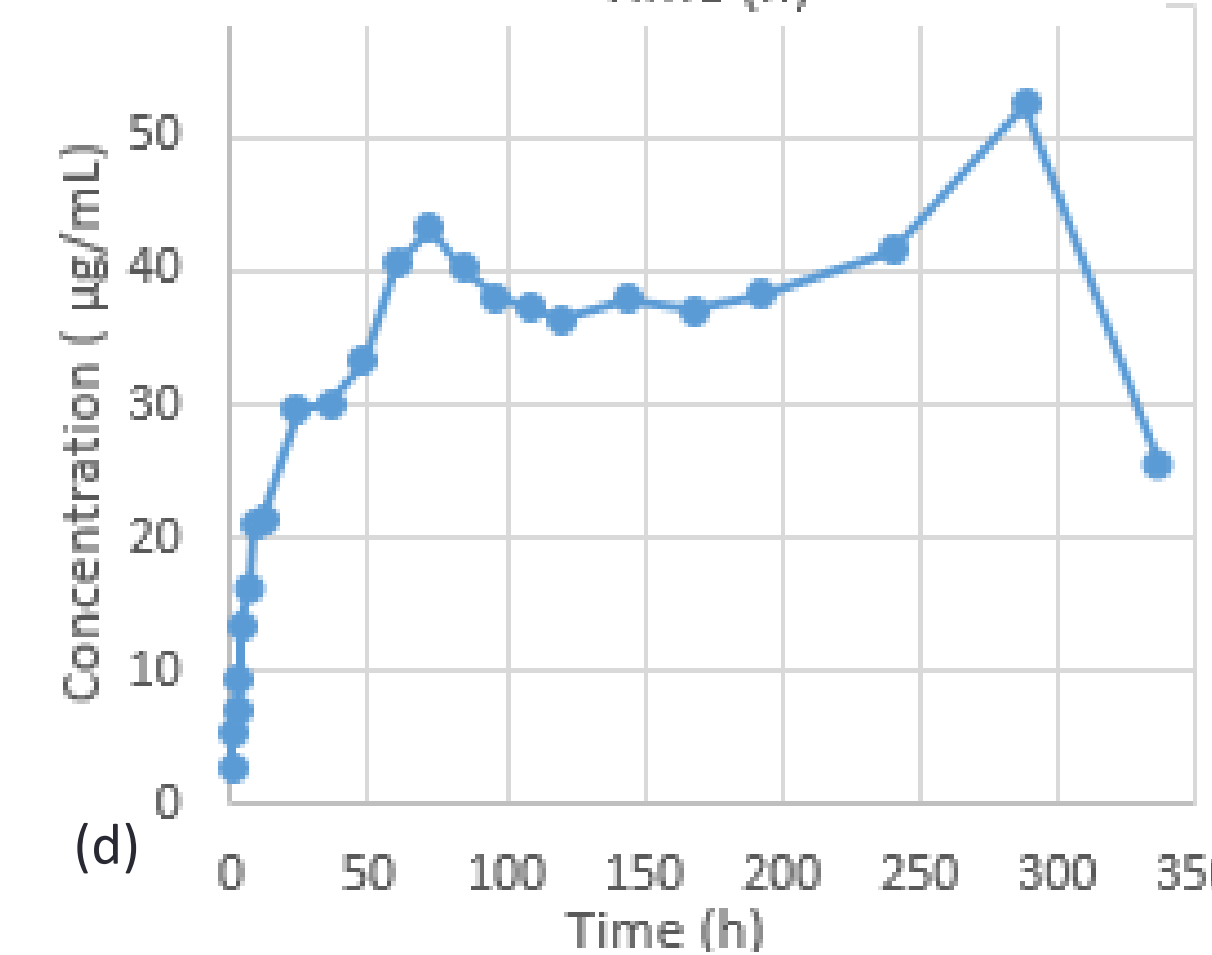
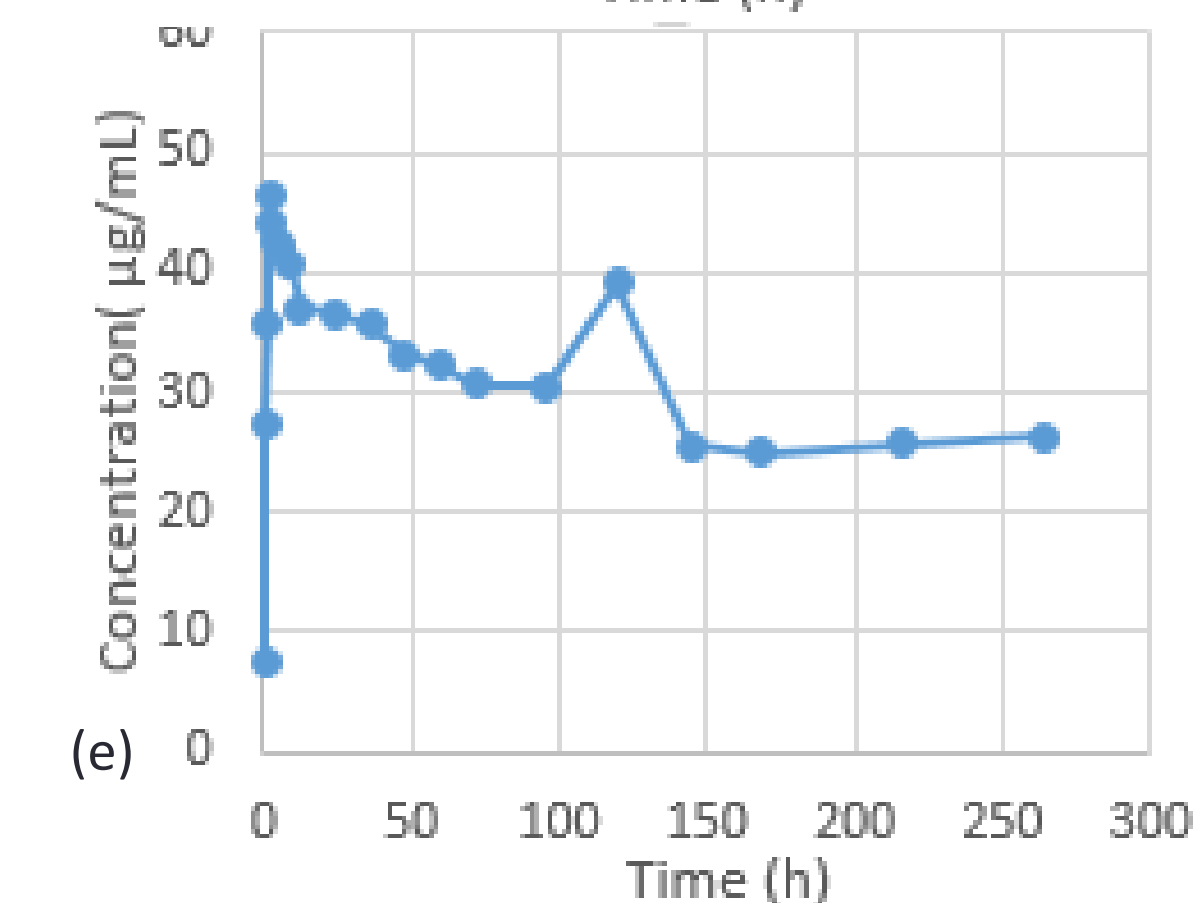
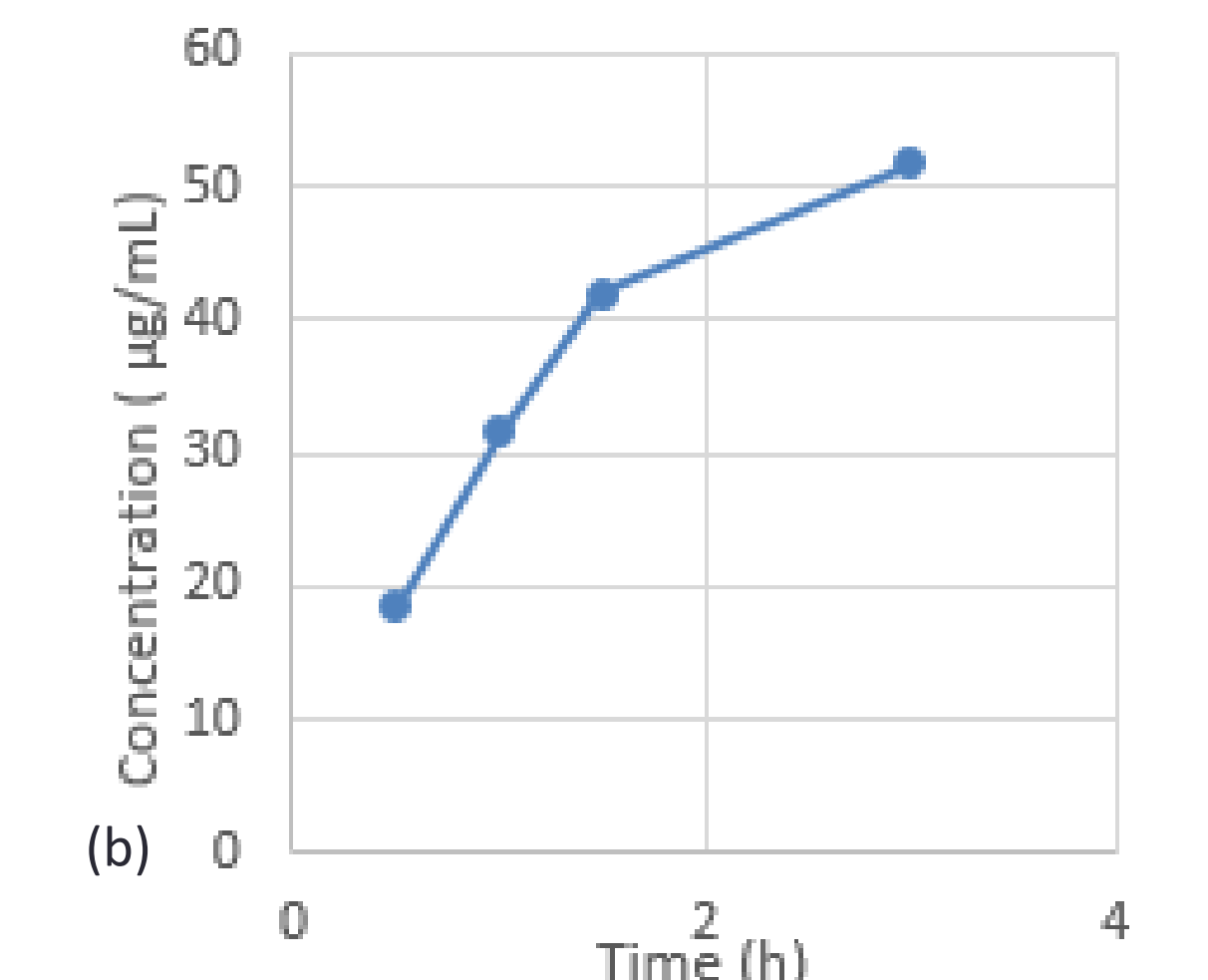
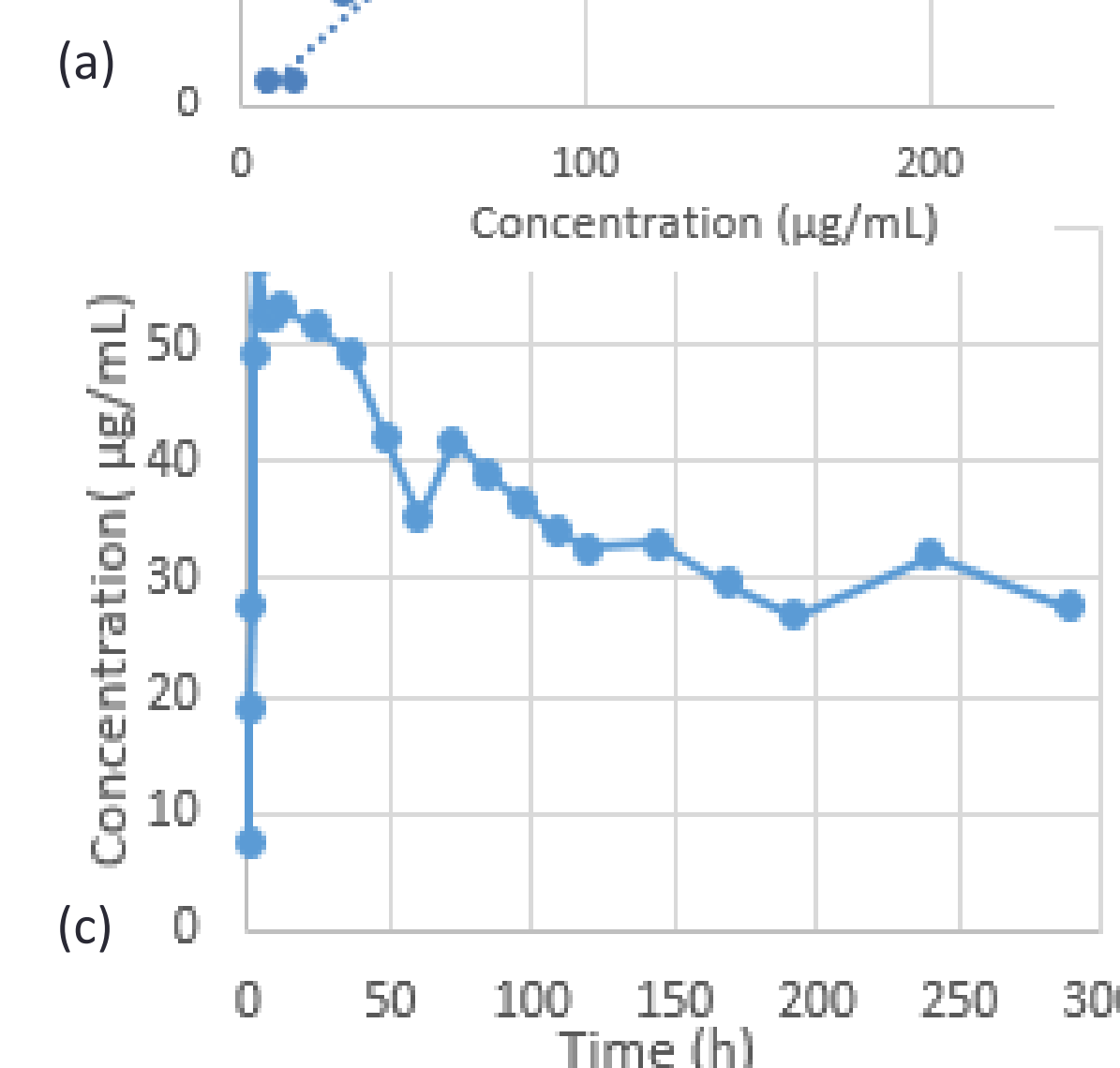
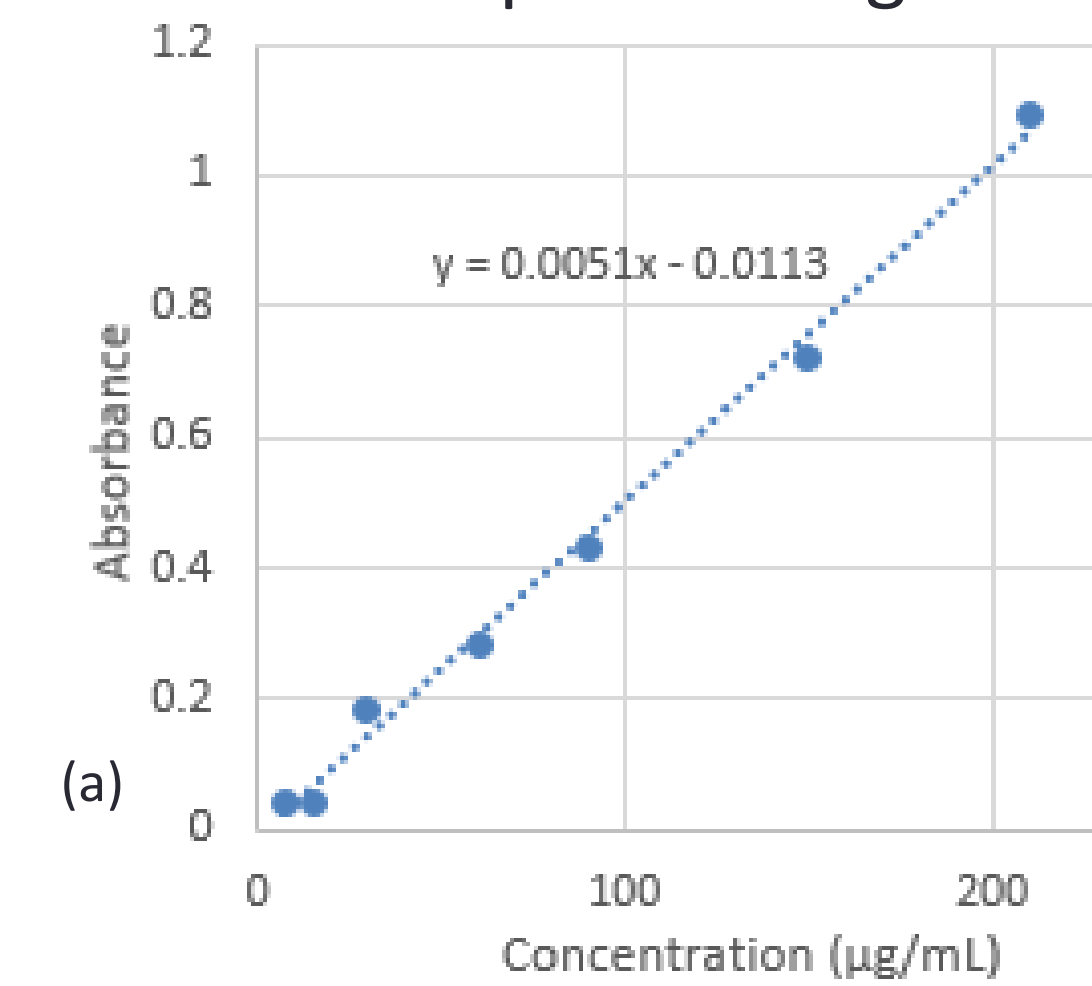


Figure 5. (a) Standard line for urea releasing. (b) Urea releasing curve without coating. (c) 120 °C solid-liquid coating. (d) 140°C solid-liquid coating. (e) 140°C solid-solid coating. (f) 160°C solid-liquid coating. The absorbance point was picked at 440nm to calculate concentration value.

- From figures above, coated hydrogel showed potential in controlling urea releasing. Both samples (d) and (e) were coated at 140°C but manipulated with different coating method. Sample (d) displayed a better capacity in controlling urea releasing for 10 days
- Comparing samples (c), (d), and (f), which were taken out after a certain amount of time, samples (d) and (f) indicated better coating results corresponding to urea concentration.

## Conclusions

- The lignin-based hydrogel was successfully prepared through a easily operated and environmental friendly method, which may substitute petro-based method in producing hydrogel.
- The most efficient coating resulted as temperature set from 140°C to 160°C. Polymer coating on hydrogel has potential capacity in controlling urea releasing.
- Future work in coating can be focused on pH environment, material mass, and temporal control. Epoxy may be adjusted or substituted by biodegradable products. The swelling capacity of hydrogel could be explored and applied with its releasing ability as a beneficial agricultural support.

## Acknowledgement

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