

# Understanding the Recyclability of Ionic Liquids and its Interaction with Silk/Cellulose Biomaterials

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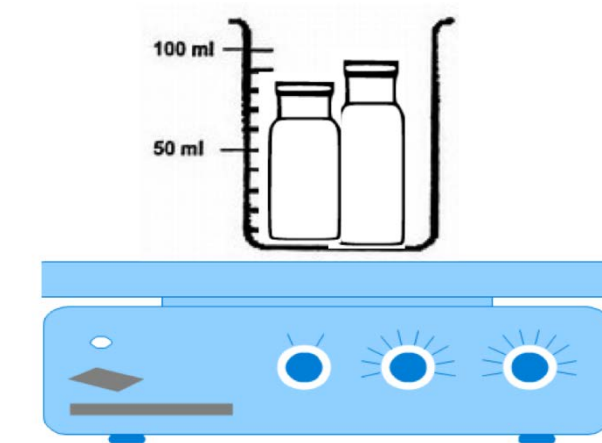


## Introduction

- Silk is a natural textile fiber that comes from the silkworm.
- Cellulose is an organic compound that can be found in the structural wall of plants.
- Cellulose molecule contains Hydrogen, Oxygen, and Carbon.
- Ionic Liquid is an organic salt at room temperature in its liquid state.
- In the experiment Silk and Cellulose biocomposite were formed from Ionic Liquid
- The IL that was used in this experiment was 1-ethyl-3-methylimidazolium chloride (EMIMCL) due to its high dissolution capabilities in dissolving cellulose according to NCBI.
- EMIMCL disrupted the hydrogen bonding between Cellulose and Silk.
- The purpose of this experiment is to consecutively reuse the Ionic Liquid (IL) that was used in the previous experiment.
- The objective is to evaluate the potential microscopic contamination in the IL.
- The hypothesis states that the purity of the ionic liquid is reduced due to a lower concentration of non-precipitated reactant of cellulose and silk in solution therefore preventing further reuse.

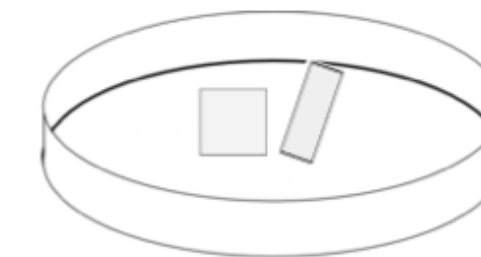
## Methods

### 100% Water Bath



#### Day 1

The EMIMCL was put in oil on a hot plate that was at 82.5°C. Silk was added into EMIMCL. Cellulose was added afterwards.

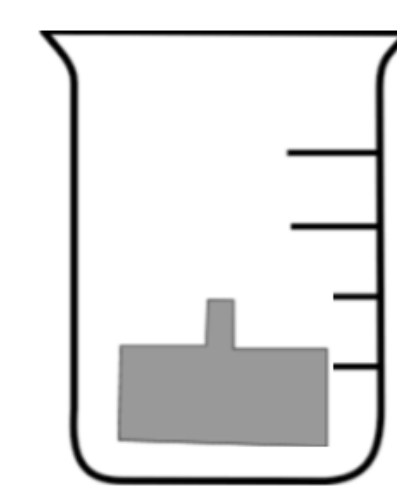


#### Day 2

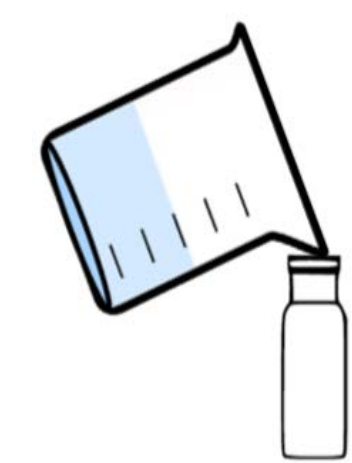
The films were inserted onto a Petri dish and placed in the vacuum. The 100mL Water Bath was put in the oven for 24 hours.

#### Day 3

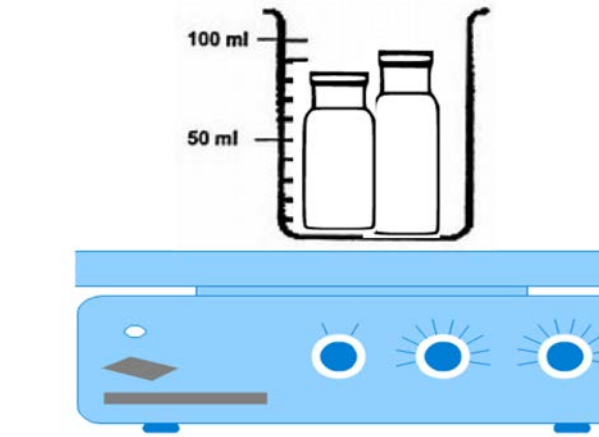
About 12.5 mL of distilled water was added to the EMIMCL. When it was washed, it was transferred into a vial and placed in the vacuum oven for 24 hours.



The solution was placed on a mold that was inserted into a 100 mL Water bath for 24 hours.

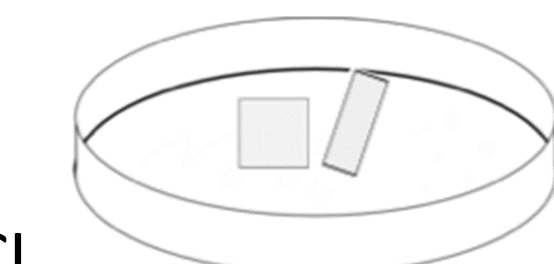


### 50mL Ethanol/ 50 mL Water Bath



#### Day 1

The EMIMCL was put in oil on a hot plate that was 82.5°C. Silk was added into EMIMCL. Cellulose was added afterwards.

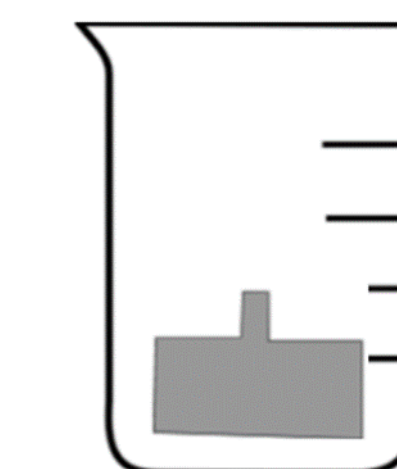


#### Day 2

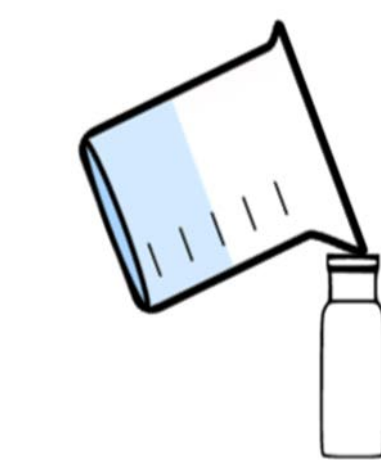
The films were placed onto a Petri dish and placed in the vacuum. The 50mL Ethanol/50mL Water Bath was left under fume hood and then placed in the oven the following day.

#### Day 3

About ~10mL-15mL of distilled water was added to the EMIMCL. When it was washed, it was transferred into a vial and placed in the vacuum oven for 24 hours.

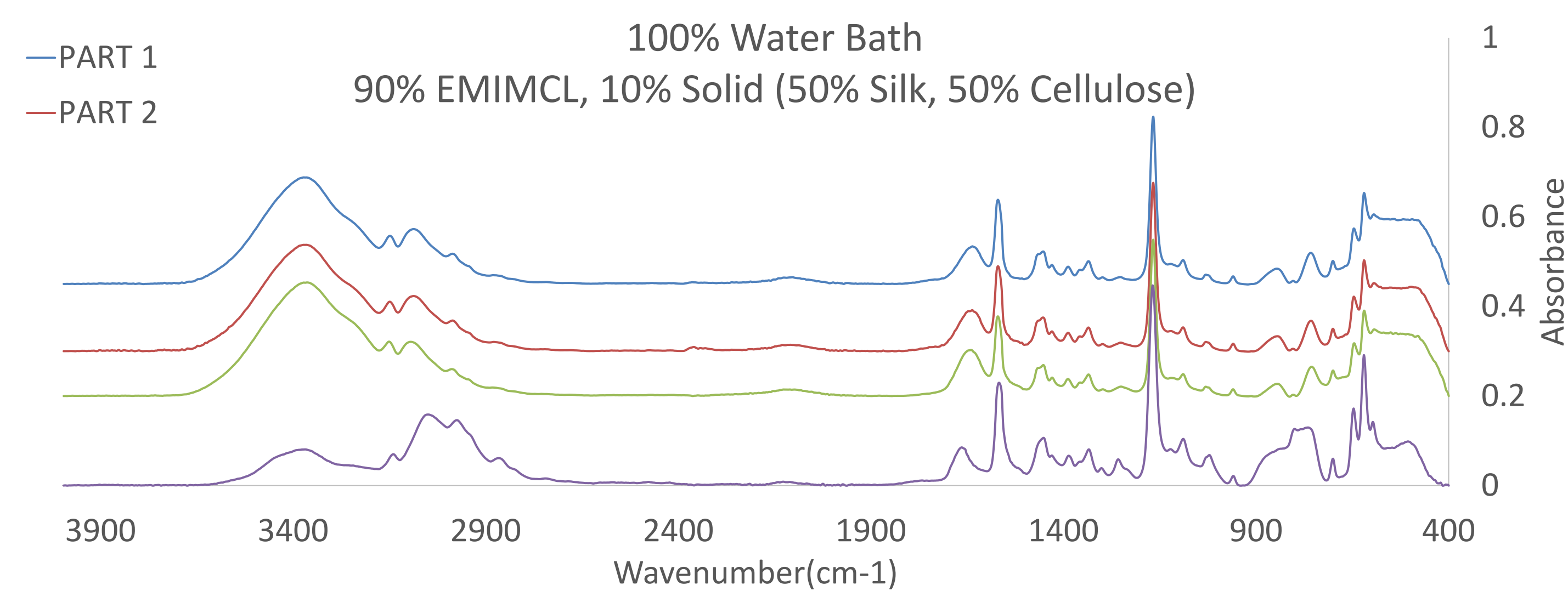


The solution was placed on a mold that was inserted into a 100 mL for 24 hours.

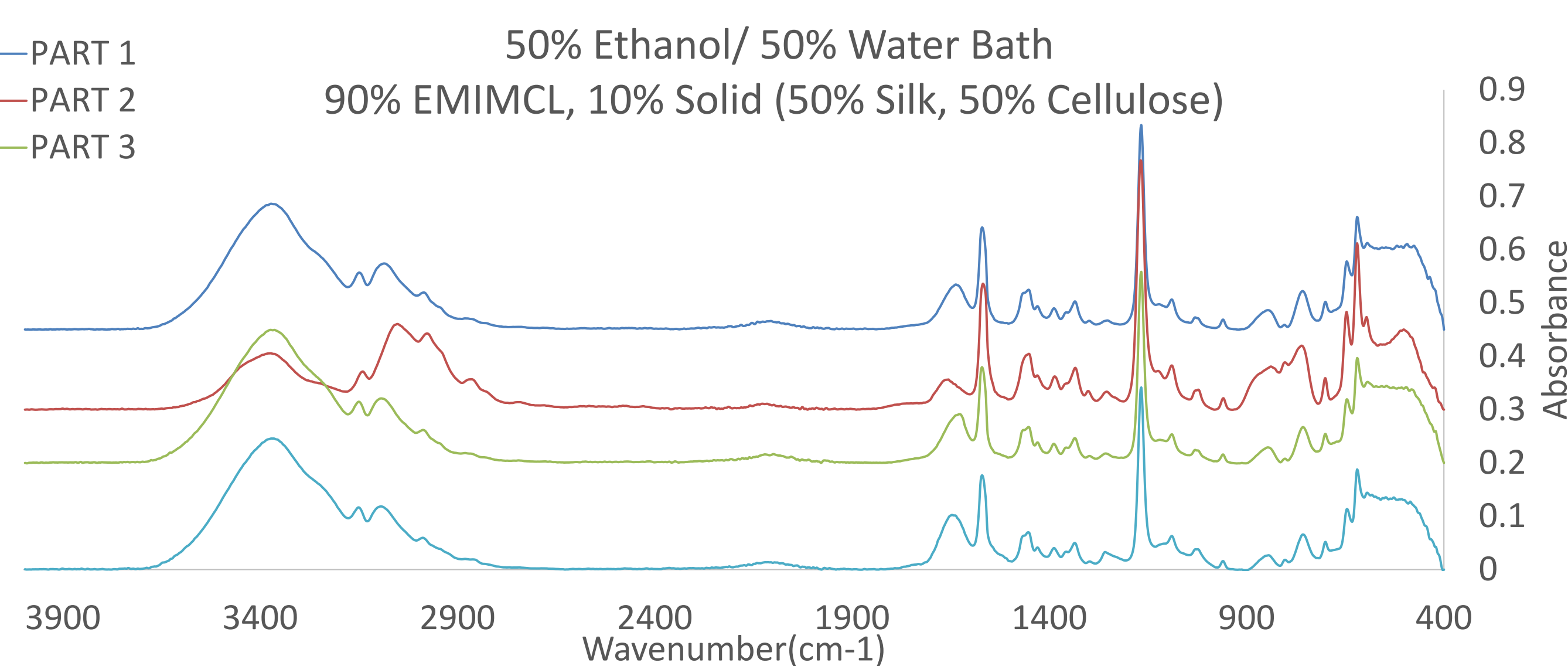


## Results

Graph 1: The FTIR of the Ionic Liquid that was extracted from the Water Bath after each experiment



Graph 2: The FTIR of the Ionic Liquid that was extracted from the Ethanol and Water Bath after each experiment



100% Water Bath	Correlation
Part 1- 0.45g EMIMCL, 0.025g Silk, 0.025g Cellulose	68.90%
Part 2- 0.328g EMIMCL, 0.018g Silk, 0.018g Cellulose	73.86%
Part 3- 0.1439g EMIMCL, 0.016g Silk, 0.016g Cellulose	73.47%
Part 4- 0.244g EMIMCL, 0.0135g Silk, 0.0135g Cellulose	87.50%

Fig 1. This table shows the correlation of the Pure Emimcl with the Ionic Liquid after each experiment. The threshold of the correlation was 90%.

50% Ethanol/ 50% Water Bath	Correlation
Part 1- 0.45g EMIMCL, 0.025g Silk, 0.025g Cellulose	75.29%
Part 2- 0.3996g EMIMCL, 0.0222g Silk, 0.0222g Cellulose	94.63%
Part 3- 0.101g EMIMCL, 0.0055g Silk, 0.0055g Cellulose	71.17%
Part 4- 0.0728g EMIMCL, 0.0036g Silk, 0.0036g Cellulose	66.78%

Fig 2. This table shows the correlation of the Pure Emimcl with the Ionic Liquid after each experiment. The threshold of the correlation was 90%.

## Observations

- Dissimilar peaks are observed in the IR spectra.
- The IR spectra confirmed the presence of Cellulose resulting in a presumption that the Ionic Liquid accumulates fragments of undissolved Cellulose after each use.
- The IR spectra conformed the presence of silk material
- Different correlations are observed for a system coagulated with water and with ethanol
- Using only water as a cleaning agents does not guarantee an increase in purity.

## Future Direction

Future studies will be conducted to find a method of filtration to purify the Ionic Liquid using filtration membranes and cooling.

## Acknowledgements

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## References

### Works Cited

Li, Y., X. Liu, S. Zhang, Y. Yao, X. Yao, J. Xu, and X. Lu. "Dissolving Process of a Cellulose Bunch in Ionic Liquids: A Molecular Dynamics Study." *Physical Chemistry Chemical Physics : PCCP*. U.S. National Library of Medicine, 21 July 2015. Web.  
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