

## Part I : Nanoparticle Preparation

Siripon Wattanasing and Kiattikhun Manokruang  
Department of Chemistry, Faculty of Science, Chiang Mai University

### Abstract

Food safety has a significant impact on human health and the well-being of the global population. According to The World Health Organization (WHO) in 2020, foodborne diseases exhibit symptoms that range from mild gastroenteric issues to more severe neurological, hepatic, and renal syndromes, affecting approximately 600 million people worldwide. WHO plays a huge role in promoting food safety globally. Hence in this research, stimuli-responsive polymers have been developed which can alter their morphological structures through physical or chemical changes in response to external environment such as pH, temperature, or solvents. This study aims to prepare nanoparticles of poly(methyl methacrylate-co-methacrylic acid) (P(MMA-co-MAA)) that respond to pH changes (pH-responsive) in spoiled food. The carboxylic groups (-COOH) in the polymer are pH-sensitive, and food spoilage is typically results from chemical changes such as oxidation, discoloration, or physical changes caused by microbial growth and metabolism. During spoilage, ammonia, methane, hydrogen sulfide, and carbon dioxide are released.

Nanoparticles were prepared using the single-emulsion method. Results showed that the optimal ratio of 0.25% w/v (P(MMA-co-MAA)) in chloroform to polyvinyl alcohol (PVA)-dissolved water medium, at 8:40 mL, produced the highest yield of nanoparticles. Subsequently, the appropriate concentration of PVA, as an emulsifier for nanoparticle preparation was studied at the varied concentrations of 0.5%, 1%, 2%, 3%, and 4% w/v in water, which produced nanoparticles with sizes of 661.17, 548.83, 688.30, 614.73 and 647.93 nanometers, respectively, as measured by a Zeta-sizer. These nanoparticles are further intended to encapsulate dyes (such as Nile red) to use as spoilage indicators on food packaging film.

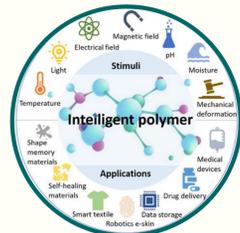
### Introduction



Food safety impacts human health and the welfare of the global population. As highlighted by the WHO in 2020, foodborne diseases with symptoms

#### Applications

- Drug delivery
- Tissue engineering
- Biosensing
- Food packaging



### Results

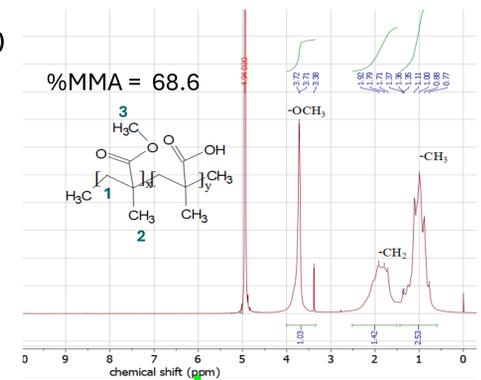
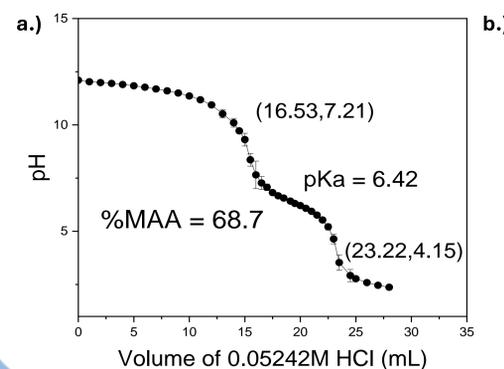


Fig 1. Determination of %MAA in P(MMA-co-MAA)

a.) Potentiometric titration graph  
b.) <sup>1</sup>H-NMR spectrum of P(MMA-co-MAA)

No.	Type of proton	Chemical shift (ppm)	Integration
1	Methylene protons (-CH <sub>2</sub> )	1.7	1.42
2	Methyl protons (-CH <sub>3</sub> )	1.0	2.53
3	Methoxy protons (-OCH <sub>3</sub> )	3.8	1.03

### Objectives

- To determine %MAA of P(MMA-co-MAA) using potentiometry and <sup>1</sup>H-NMR technique.
- To prepare the nanoparticles using emulsion method to use as food spoilage indicator.

### Methods

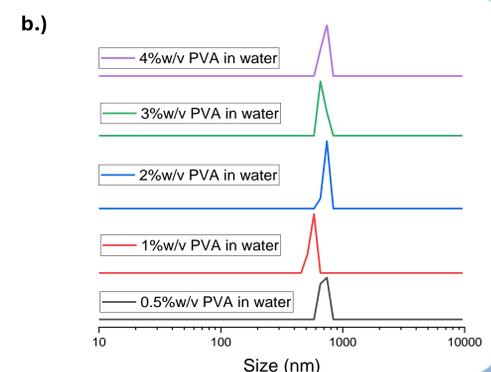
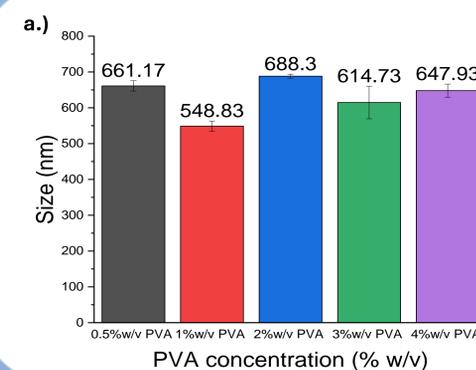
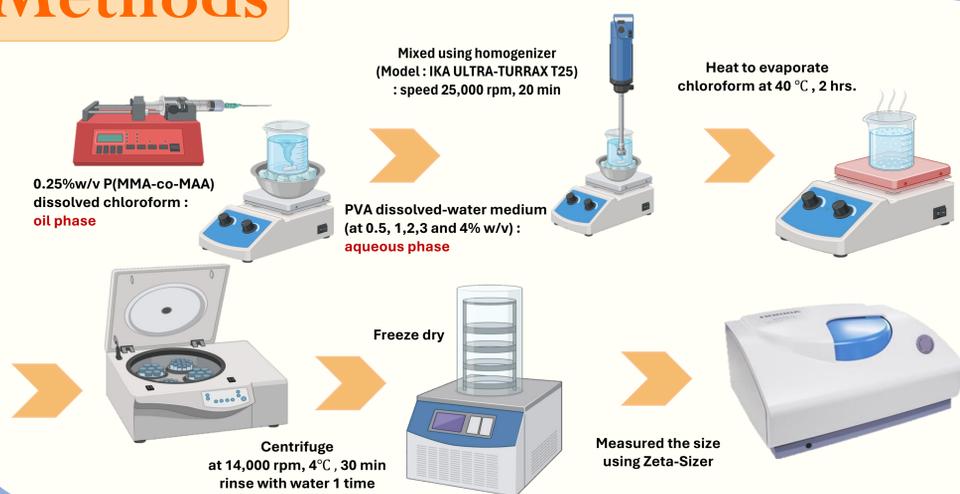


Fig. 2. Measurement of the nanoparticle size prepared in a system containing a 0.25% w/v solution of P(MMA-co-MAA) dissolved in chloroform (oil phase) and polyvinyl alcohol (PVA) dissolved in water (aqueous phase) at an 8:40 mL ratio; (a) nanoparticle size and (b) nanoparticle size distribution graph measured by a Zeta-sizer.

### Acknowledgement

This study was supported by Assoc. Prof. Dr. Kiattikhun Manokruang. His advice and direction enabled me to reach my best potential.

Finally, I would like to thank Dr. Wanwanut Chueasupcharoen, Ms. Paveena Tikakosol, Mr. Nuttawut Khammata, and Ms. Ain Us Saba for their assistance and unwavering support throughout this journey.

### References

- {1} Manokruang, K., & Manias, E. (2009). Hollow microspheres and aqueous phase behavior of pH-responsive poly(methyl methacrylate-co-methacrylic acid) copolymers with a blocky comonomer distribution. *Materials Letters*, 63(13-14), 1144-1147.
- {2} Wei, M., Gao, Y., Li, X., & Serpe, M. J. (2017). Stimuli-responsive polymers and their applications. *Polymer Chemistry*, 8(1), 127-143.

### Conclusion

- The characterization of P(MMA-co-MAA) was performed using different techniques to determine the MAA content, i.e. 68.7% from potentiometric titration (pKa = 6.40) and 68.6% from <sup>1</sup>H-NMR spectroscopy.
- In another study, nanoparticles were prepared using a single-emulsion method, where 0.25% w/v of P(MMA-co-MAA) (dissolved in chloroform) was emulsified with polyvinyl alcohol (PVA) in an 8:40 mL ratio, which resulted in the highest yield.
- The optimal PVA concentration of 1% w/v produced the smallest particle size, with an average diameter of 548.83 nm.