

MERIT Internship (Domestic) Report

School of Engineering, Material Engineering

D3 MERIT 10th

Bokyoung JEON

【Internship period】

2024年 9月 11日 ～ 2024年 10月 11日 (1 ヶ月間)

【Internship institution】

National Institute for Materials Science (NIMS), Takeshi UEKI, Senior Researcher of Mechanobiology Group, Polymeric and Biomaterial Research Center biomaterial field

【Research theme】

Development of Self-Oscillating Polymeric Materials through Ultra-High Molecular Weight Polymerization of Malonic Acid Polymers

【Research background】

The Belousov-Zhabotinsky (BZ) reaction is a well-known chemical oscillation reaction in which the use of a reductant, oxidant, and strong acid generates a spontaneous and periodic reaction cycle, resulting in redox oscillations of a metal catalyst (Figure 1). In this process, malonic acid is commonly used as the reductant to drive the BZ reaction, but various types of BZ reaction reductants with different structures have been studied. For instance, a comparison between the BZ reaction behavior using malonic acid and methylmalonic acid, which has a substituted α -proton, revealed that with methylmalonic acid, the induction period and the oxidized state time were prolonged. This result is believed to be due to the lower enolization rate, which delayed specific reactions among the three processes of BZ reactions. In this internship, I aimed to develop ultra-high molecular weight polymeric reductants for use in the BZ reaction.

【Details of implementation】

Ionic liquids are liquids composed of cations and anions, and their properties are determined by the combination of these ions (Figure 2). Therefore, before using less well-known chemical substances, it is necessary to scan their solubility in various ionic liquids. Especially, using ionic liquids as a reaction solvent in polymerization reduces the activation energy for polymer growth, enabling the synthesis of ultra-high molecular weight polymers. In this internship, I selected suitable ionic liquids

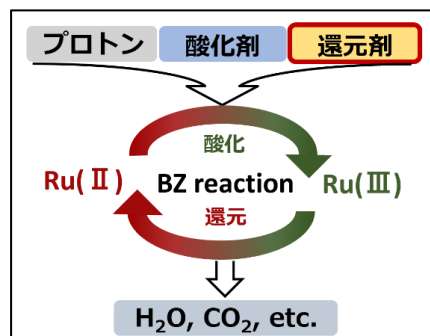


Figure 1. Schematic illustration of the BZ reaction

for polymerization through scanning and repeatedly performed polymerization to establish the conditions for obtaining ultra-high molecular weight polymers. Subsequently, the structure was confirmed by nuclear magnetic resonance, and a material was obtained for synthesizing the new structure of a BZ reaction reductant.

【Impressions】

In this internship, I synthesized ultra-high molecular weight polymers using ionic liquids. Although I had experience with low molecular weight compounds and polymer synthesis, it took time to get accustomed to working with ionic liquids and ultra-high molecular weight polymers. Beyond gaining research experience in ultra-high molecular weight polymers, I was deeply impressed by the research environment at the Japanese research institute. While I acquired knowledge and techniques through my research, the opportunity to directly experience Japanese research culture and workplace atmosphere was a significant learning experience for me. Contrary to my expectations of a closed environment, the research institute had a highly internationalized setting, which was particularly impressive. Researchers from various nationalities collaborated and interacted actively, highlighting the importance of a global research environment. Additionally, I found the efficient work environment to be beneficial for my future research career.

A particularly memorable personal moment during the internship was seeing a rainbow on my way home (Figure 3). Amid the tension of working in a new research setting, the rainbow brought a sense of calm. Such small moments accumulated to further strengthen my goal of working at a Japanese research institute.

【Acknowledgements】

I would like to express my sincere gratitude to all members of the Mechanobiology Group for their teaching during the internship. I also deeply appreciate the support for living expenses and transportation, which allowed me to fully concentrate on my research and gain valuable experiences with peace of mind. I would like to thank the MERIT Program and my supervisor, Prof. Yoshida, for providing me with such a valuable internship opportunity.

【Image reference】

1) Zhuo, Yue, et al. *Pharmaceutics* 16.1 (2024): 151.

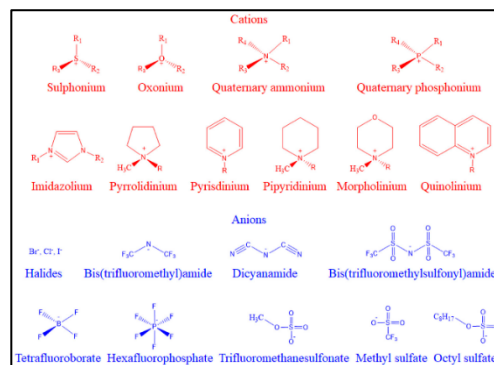


Figure 2. Common ionic liquid¹

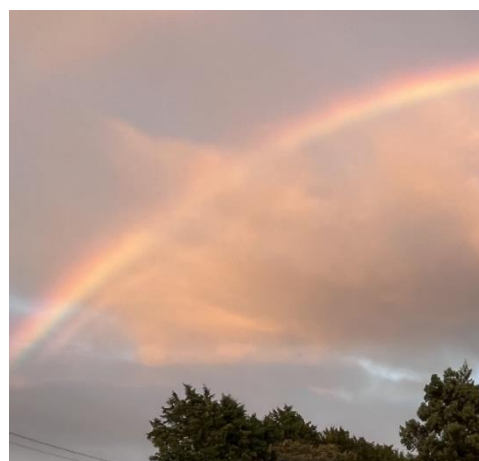


Figure 3. Rainbow in Tsukuba