Final Report on MERIT Internship

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D3 Student
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Host Institution
National Institute of Advanced Industrial Science and Technology (AIST)
Interdisciplinary Research Center for Catalytic Chemistry
Flow Chemistry and Digital-Driven Chemistry Team

Activities
In recent years, continuous flow reactions have attracted attention in the field of organic synthesis as an alternative to conventional batch methods for the production of fine chemicals. In batch processes, scale-up often involves the use of large reactor vessels, which can present challenges such as heat control and stirring efficiency. In contrast, continuous flow reactions allow productivity to be controlled by adjusting the operating time of raw material supply, making it easier to scale up results obtained on a small scale. Additionally, their continuous operation enables stable production, and they can also be applied to multi-step reactions. Notably, in continuous flow reactions using heterogeneous catalysts, catalyst separation steps become unnecessary, as the catalyst is packed into a column, allowing the desired product to be obtained simply by passing the raw materials through the system.

During this internship, I conducted scale-up studies on the continuous flow synthesis of fine chemical intermediates. In flow synthesis using column-type reactors, in addition to optimizing reaction conditions, key challenges include catalyst packing methods and control of raw material flow. In my doctoral studies, I have been engaged in the development of organic reactions and heterogeneous catalysts utilizing continuous flow systems. While this internship provided an opportunity to apply my knowledge and skills to reaction

development, conducting experiments on a different scale from the university research environment also presented new challenges that I had not previously encountered.

For example, in small-scale experiments, plunger pumps are typically used to feed substrate solutions, and issues are rarely encountered. However, in this internship, the use of pumps capable of handling more complex and high-flow solutions often led to an increase in system pressure. This issue stemmed from the use of a column-type reactor, requiring a detailed investigation of catalyst packing techniques to address the problem. Although there were instances where experiments did not proceed as expected, repeated trials with different equipment allowed me to resolve issues and gain valuable hands-on experience.

Acknowledgments
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