



University  
of Victoria

Graduate Studies

Notice of the Final Oral Examination  
for the Degree of Master of Science

of

**MICHELLE YAN CHI TING**

BSc (York University, 2016)

**“Monitoring Complex Reactions using Tandem Mass  
Spectrometric Methods”**

Department of Chemistry

Thursday, April 25, 2019

2:00 P.M.

Elliott Building

Room 228

Supervisory Committee:

Dr. Scott McIndoe, Department of Chemistry, University of Victoria (Supervisor)  
Dr. Fraser Hof, Department of Chemistry, UVic (Member)

External Examiner:

Dr. Matthew Bush, Department of Chemistry, University of Washington

Chair of Oral Examination:

Dr. Christopher Eagle, Department of Mathematics and Statistics, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

## **Abstract**

Suzuki-Miyaura cross-coupling is a well-known method for making biaryls. With bifunctional monomers, Suzuki polycondensation (SPC) can be used to make polyaryls. Given the complexity of the reacting solution, studying the mechanism of SPC is extremely tough. To solve this problem, we used tandem mass spectrometric (MS/MS) methods to observe the dynamic behaviour of catalytically relevant species in real time.

Catalysis involves a complex soup of reactants, intermediates and products. We used an ESI-MS with a triple quadrupole mass analyzer to monitor the SPC in positive ion mode using pressurized sample infusion (PSI) in real time. Full scan, selected ion recording (SIR), product ion scan, neutral loss scan (NLS) and multiple reaction monitoring (MRM) MS/MS methods were applied. Tetrakis(triphenylphosphine) palladium(0) was the catalyst of this reaction and a positively charged phosphonium aryl iodide tag ( $m/z$  478) was implemented into the first catalytic cycle, enabling us to track all the intermediate oligomers up to the 4<sup>th</sup> addition. Product ion scan revealed all the intermediate oligomers lose a triphenylphosphine fragment ( $m/z$  262) which would either come from the complex or the charged tag. Three significant intermediate types were observed in each stage of the catalysis, oxidative addition, transmetalation and reductive elimination and their behavior was studied in a chronogram, normalized to the total ion current (TIC). As expected, the use of selected ion recording and neutral loss scan dramatically improved the signal-to-noise ratio. Ultimately, multiple reaction monitoring showed the best chronogram data due to the fact that this scan acts as a “double filter” in a soup of reactive species and contaminants.

Real time reaction monitoring has proven to provide detailed insights regarding a reaction. MS/MS methods are promising for improving data quality, selectivity and sensitivity in reaction monitoring. The principle is broadly applicable to other systems, from an intricate catalytic reaction with short-lived ionic intermediates to a reaction with only a single product generated. Reaction dynamics for an exceptionally complex reaction can be made simple and easy by utilizing tandem mass spectrometry methods in time resolved reaction monitoring.