

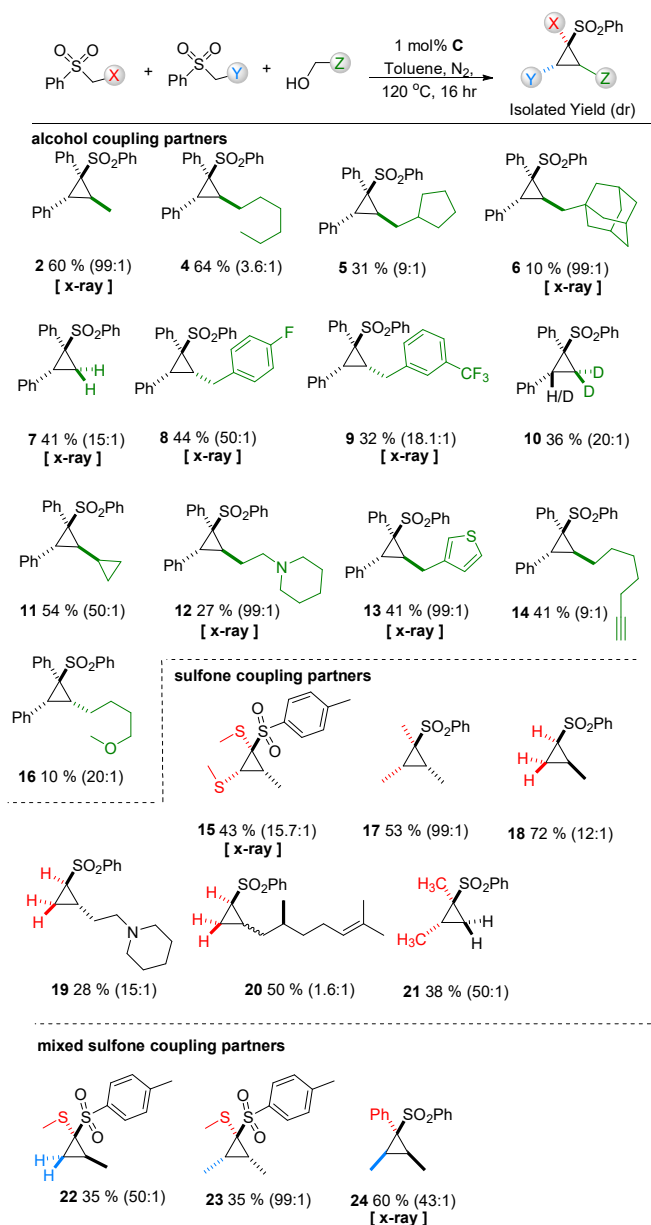
Science and Technology Group Annual Report FY2017

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1 Introduction

During FY2017, I focused on the synthesis of highly diastereoselective cyclopropanes, a reaction that was discovered in at the beginning of 2017 before the start of the fiscal year. Together with a visiting undergraduate intern at OIST, we managed to make quite a large number of cyclopropanes with different functional groups, some of them in large isolated yields. This work was presented at the Canadian Chemical Society meeting (lecture), at the Organometallic Gordon conference (poster), the American Chemical Society meeting (lecture) and at the Japanese Society of Chemistry 98th annual march meeting (lecture). Before the end of the fiscal year, the work was published online on the ChemRxiv preprint server. A provisional patent was filed for this invention as well.

2 Activities and Findings



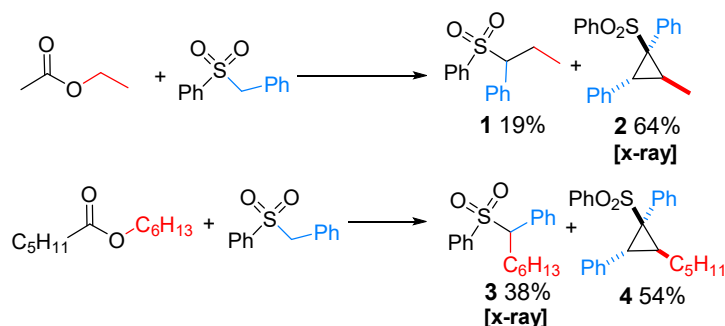
Reproduced to the left is the general scheme of the cyclopropanation reaction and a number of cyclopropanes that resulted in a good yield of the product. The main advantages of the reaction are that it is only one step, and yields a number of electron-rich cyclopropanes that are difficult to synthesize by other means. Product **10** is the first example of a selectively deuterated cyclopropane that is formed from only one step. Many of the products contain three new chiral centers and a new, quaternary carbon center, which are normally difficult to synthesize. If two sulfones with different pKa values are used, we can relatively cleanly get mixed products where two substituents on the ring are from different cyclopropanes, with the more acidic sulfone remaining on the ring (**22-24**).

Based on mechanistic studies, we determined that the catalyst is only responsible for the initial dehydrogenation of the alcohol substrate, or the creation of an aldehyde moiety from the alkoxy part of the ester substrate. However, the catalyst is crucial in order to get a high

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yield of the product since it produces aldehyde at a steady and slow rate. Under the reaction conditions, starting with pure aldehyde causes significant disproportionation and much lower yields. At the time of submission of this report, the associated paper based on the preprint, has been accepted for application in *Organometallics* and a decision has been made to proceed with filing a full patent application based on this technology.



Other notable projects during the year include one that arose from the cyclopropane work, as it was found that the reaction can lead to another possible product, a linear sulfone, which may be formed selectively upon varying the catalyst identity

and the reaction conditions. As can be seen in the scheme, the linear products are minor, but we have recently found conditions where they are the major product. We are currently exploring this reactivity. Another project that will be presented in the next report but was started in the last third of FY2017 is an interesting rearrangement reaction in PNP-Ru complexes, where the ligand backbone is modified by a pendant pyridine moiety.

3 Collaborations

See FY 2016 report. Still continuing with the same nickel complex collaboration with a paper to be submitted (and likely published) in FY 2018. The most salient finding is that highly sterically hindered Ni^I complexes have drastically different geometries and single electron occupied orbital that vary greatly based on whether the substituent on the phosphine donor is ⁱPr or ^tBu.

4 Publications and other output

Author list, *Title*, Journal or other reference, volume information (year)

Publication: Tanner C. Jenkins; Robert R. Fayzullin; Eugene Khaskin, *Three-Component [1+1+1] Cyclopropanation with Ruthenium(II)*, ChemRxiv, March 2018

Provisional Patent: Eugene Khaskin, *Cyclopropanation Method*, SY7OI-1001.

Presentation: Khaskin E. (presenting author); Tanner C. Jenkins; Robert R. Fayzullin, *Serendipitous discovery of a cyclopropanation of aliphatic esters and alcohols with a homogeneous Ru(II) catalyst arising from ester metathesis chemistry*, 100th Canadian Chemistry Conference at Toronto, Ontario May 28 – June 1, 2017; Organometallic Gordon Conference, July 9-14, Rhode Island, USA (included nickel collaboration and co-author Sebastian Lapointe), American Chemical Society Fall meeting in Washington DC, August 20-24; Japanese Society of Chemistry 98th annual meeting at Nihon University, Funabashi campus. March 20-23, 2018.