



Defeating Environmental Villains: Synthesis of Catenanes to Produce Deformation-Resistant Tanglemers

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Introduction

Currently, polymers with high cross-linking densities are more susceptible to deformation and are thus harder to recycle. Tanglemers, polymers in which entanglements are more concentrated, have been shown to be stiffer, tougher, and can deconcentrate stress across the entirety of the system. Thus, the question asked in this study was: *to what extent can tangled elastomers be synthesized utilizing [2]catenane 26-Cu and maleic anhydride as a mechanophore?* The results showed progress within the synthesis, suggesting the feasibility of the final product.

Materials and Methods

Achieving Suzuki Coupling:

- Boronic acid and dichloro-phenanthroline was reacted with a palladium catalyst to produce the bis-phenanthroline product
- This reaction was left overnight and purified via column chromatography

Deprotection Step:

- The bis-phenanthroline product was reacted with boron tribromide in order to achieve the two alcohol groups shown in Fig. 1.
- This step took about 4 hours

SN2 With Alkoxy Group:

- Reacted with 2-(2-chloroethoxy)ethan-1-ol and caesium carbonate at room temperature, left overnight



2-(2-chloroethoxy)ethan-1-ol and caesium carbonate SN2 reaction

Results

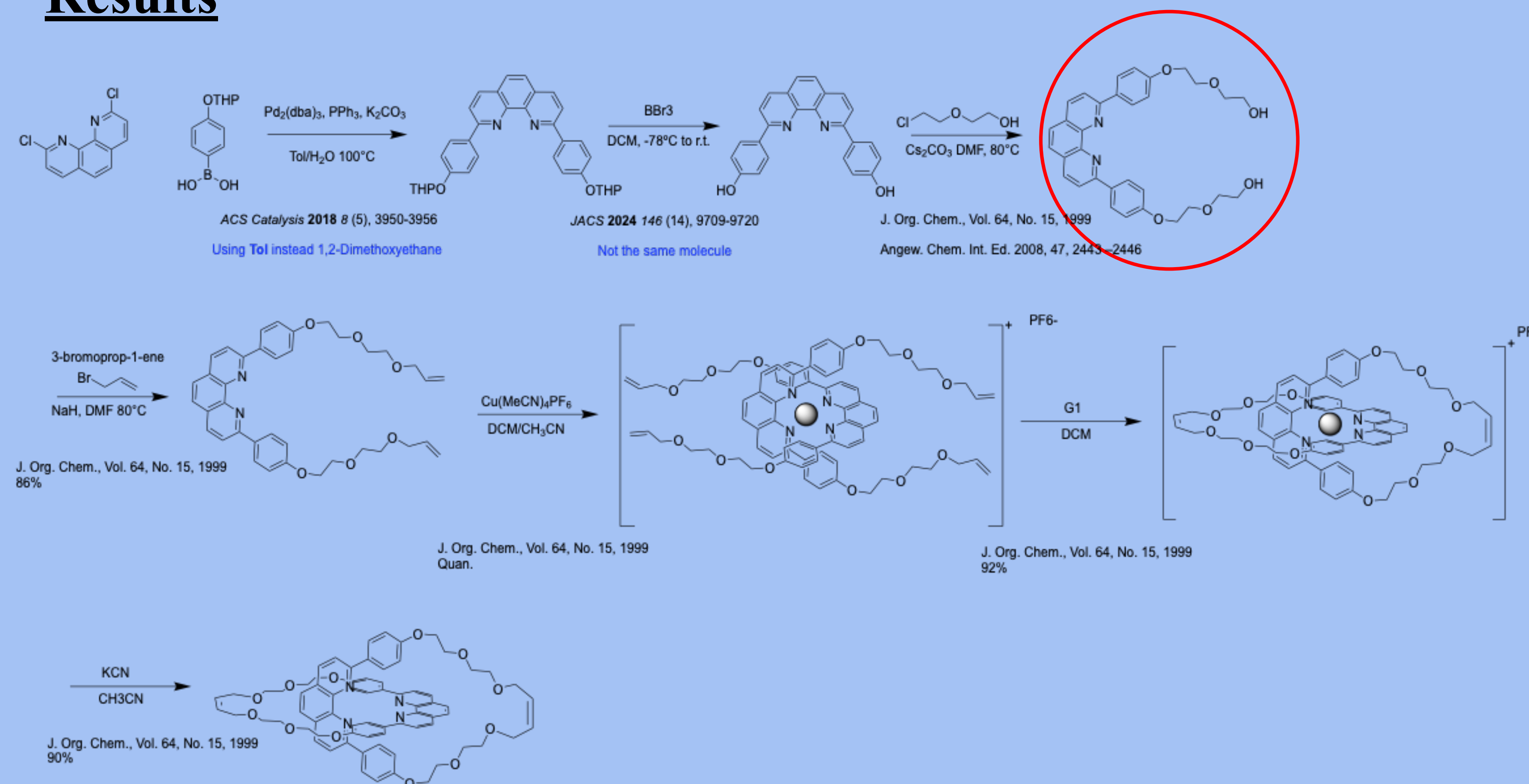


Fig. 1. The following figure shows the synthetic route to achieving the final catenane product. The circled result is the product achieved so far in this experiment.

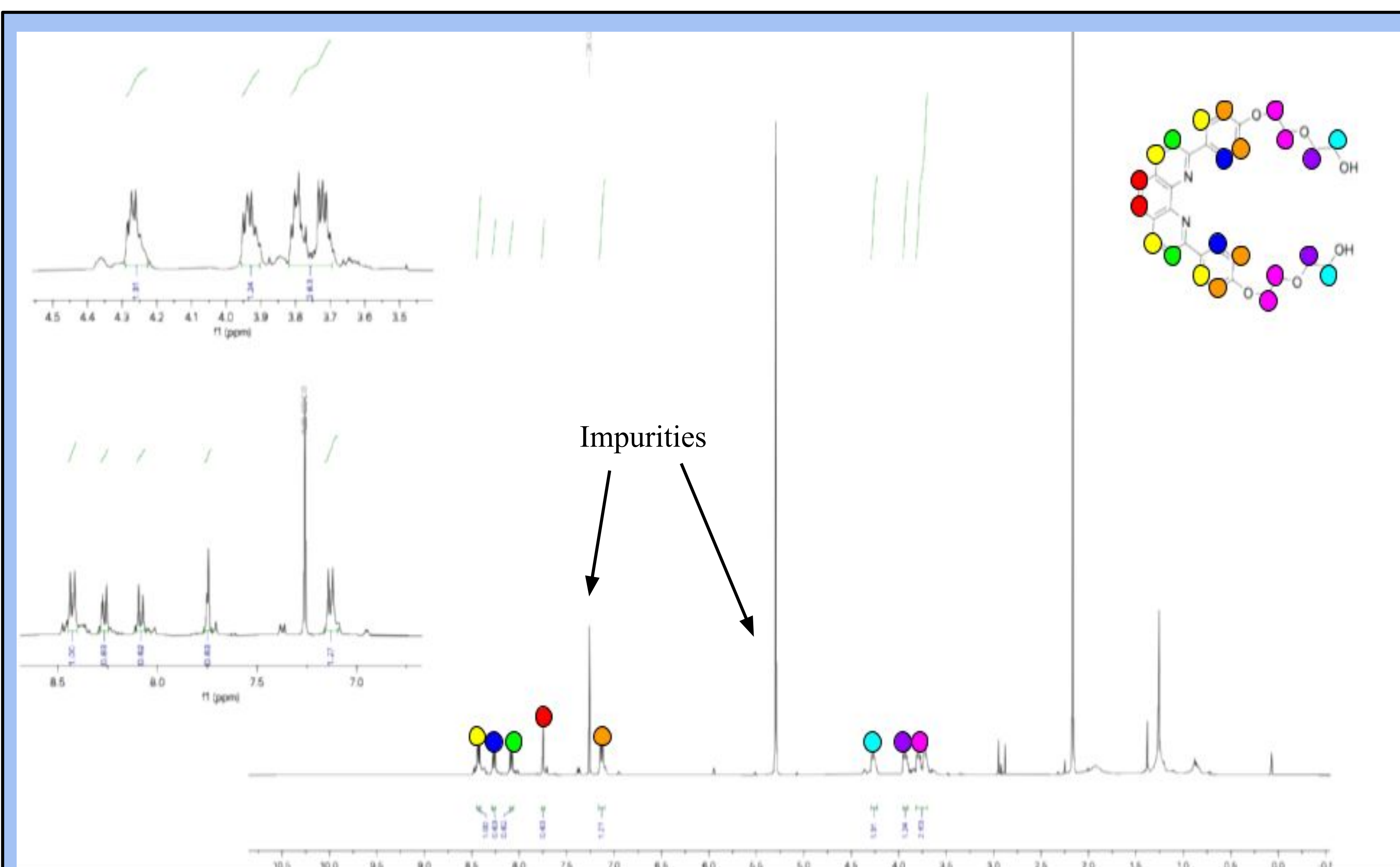


Fig. 2. This figure showcases the NMR for the final product. As can be seen, the product was achieved with impurities.



Conclusions

Preliminary NMR results, as seen in Fig. 2., show that the third product of the synthesis was successful: the alkoxy group was attached to the phenanthroline, which suggests the success of the final product. The next steps for this study will be to achieve the SN2 reaction with the 3-bromoprop-1-ene, which is anticipated to be the hardest step of the reaction.

Further Studies

- Achieving these catenanes through a more efficient synthetic route with less steps
- Exploring ways to avoid synthesizing these catenanes to produce the desired tanglemers

Acknowledgments

- Supported by the Laidlaw Foundation and the MONET Center for the Chemistry of Molecularly Optimized Networks
- I would like to also thank Valentina Malave for working on this project with me, Dr. Luis Campos for his mentorship, and my lab for their continuous support.



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