

Research Progress: The Teixeira lab was officially started in 2017. The zeolite crystallization facilities in the group initiated under this ACS PRF DNI with the first PhD student starting in the Fall of 2018. Since that time, we have worked diligently to establish capabilities for batch and flow synthesis of zeolites in microfluidic devices, as per the original proposal. Major progress has been made in the following areas:

1. *Baseline batch kinetics.* Autoclaves were operated at 65 C under autogenous pressures for stirred and unstirred batch crystallizations of LTA. These experiments were conducted with several crystallization times to assess the classical batch kinetics in the presence of transport limitations. Quenching and subsequent workup was performed to quantify crystallinity through XRD, SEM, N2 physisorption and Raman spectroscopy. Characteristic results are shown below.

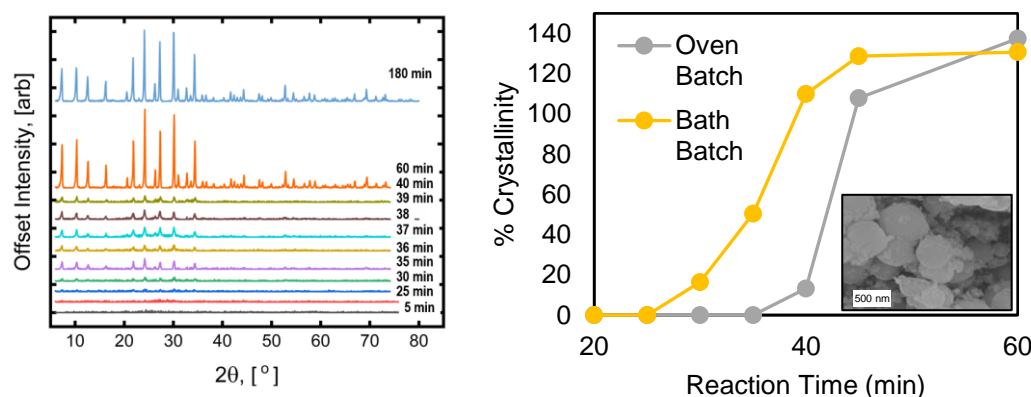


Figure 1: Batch crystallization of LTA in autoclaves at 65 C demonstrate crystallinity (XRD, left) that increases with reaction time. The batches heated by oven are substantially slower (right) than those observed by oven heating indicating a thermal transient or heat transfer limitation.

2. *Design and construction of microdroplet crystallizers.* Crystallization media was dispersed in 15 uL microdroplets confined within 1 mm PFA tubing. The droplets were formed in a custom droplet generator (see Figure 2), creating highly uniform microbatches. Crystallization was conducted at 65 C in ovens or water baths.

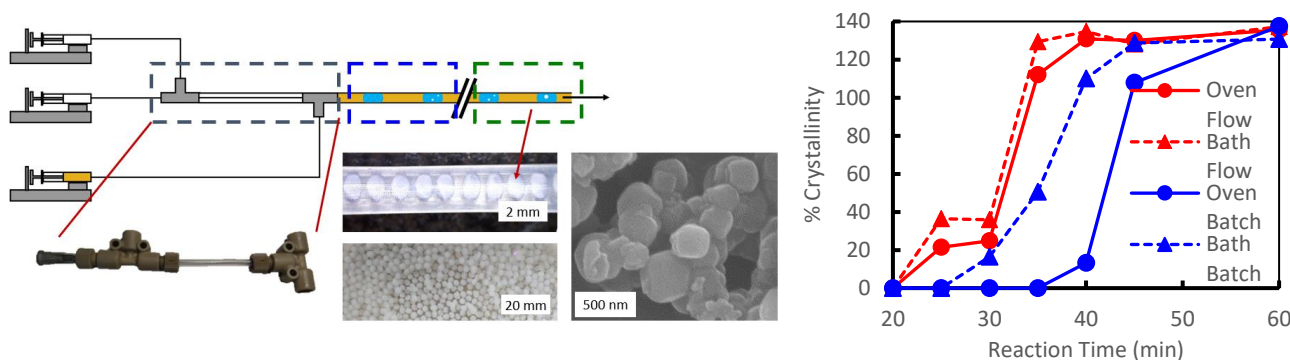


Figure 2: Left. Schematic and photographs of 15 uL microdroplet generator, microdroplets and SEM of LTA crystals formed in flow. Crystallinity measurements from *ex situ* XRD show more rapid crystallization in flow and with water heating.

Impact of Research on PI Career: This award allowed for the hiring of a PhD research assistant to establish the crystallization capabilities in the my lab. Further, the research jumpstarted my professional interactions and was the basis for invited talks by the PI at the New England Catalysis Society (NECS), North American Symposium for Chemical Reaction Engineering (NASCRE), and the Dow Chemical Company. While the work has not yet been published, it has led to recognition within the field, and will certainly be foundational within the research group.

Impact of Research on Students: The ACS PRF DNI funds were applied to a first year PhD student at WPI working within the Teixeira group. It has allowed the student to work as an RA without any TA responsibilities. The student, Jacob Crislip, has worked vigorously to collect the data included in this report, and has been recognized with second place at the institute-wide Graduate Research Innovation Exposition in 2019.