Effect of Confinement on the Formation of Calcium Carbonate

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Abstract

Crystallization is important in various scientific fields, such as materials chemistry, pharmaceutical technology, structural biology. Accordingly, the structure of materials influences their properties. The structure often depends on the processing route and processing conditions. For example, confinement has been shown to strongly influence the kinetics of the formation of CaCO\textsubscript{3} as well as on its morphology. In this thesis, we study if the production of CaCO\textsubscript{3} in 80 µm diameter drop is already influenced by confinement effects.

Experimental

- Precipitate reaction: CaCl\textsubscript{2} + Na\textsubscript{2}CO\textsubscript{3} → CaCO\textsubscript{3}↓ + 2NaCl
- Bulk solution method is conducted by direct mixing the solutions in beaker. The CaCO\textsubscript{3} is separated by centrifuge.
- Microfluidics is used to generate droplets containing the two reagents that they react inside the drops. Organic solvents are used to break up the drops thereby enabling the extraction of CaCO\textsubscript{3} particles.

Results

1. Effect of solvents
   - Adding organic solvent (acetone or ethanol) slows down the crystallization.
   - Diffusive ring within inset indicates the solvent retarding samples are amorphous.

2. Solvent/solution volume ratio
   - To retard the crystallization, the solvent/solution volume ratio should be higher than 5:1.

3. Storage time in solvents
   - Storage time in solvent should be less than 3 h.

4. Bulk solution vs. confinement
   - There is no big difference between CaCO\textsubscript{3} particles produced in bulk and in 80 µm diameter confinement.
   - FT-IR spectrum. The v\textsubscript{2} peak at 863 cm\textsuperscript{-1} confirms that particles produced in bulk and in drops are amorphous. Additional peaks in microfluidic sample are from the surfactant used in oil.

Conclusion

- Ethanol and acetone slow down the formation of CaCO\textsubscript{3}. If particles are washed with a 5:1 ethanol/water mixture they must be dried within 3 h.
- There is no big difference between particles produced in bulk solution and in 80 µm drops confinement.
- The limited amount of CaCO\textsubscript{3} produced in drops limits the methods that can be used to characterize the particles.

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