Micromixing Characteristics in Spinning Disc Reactor

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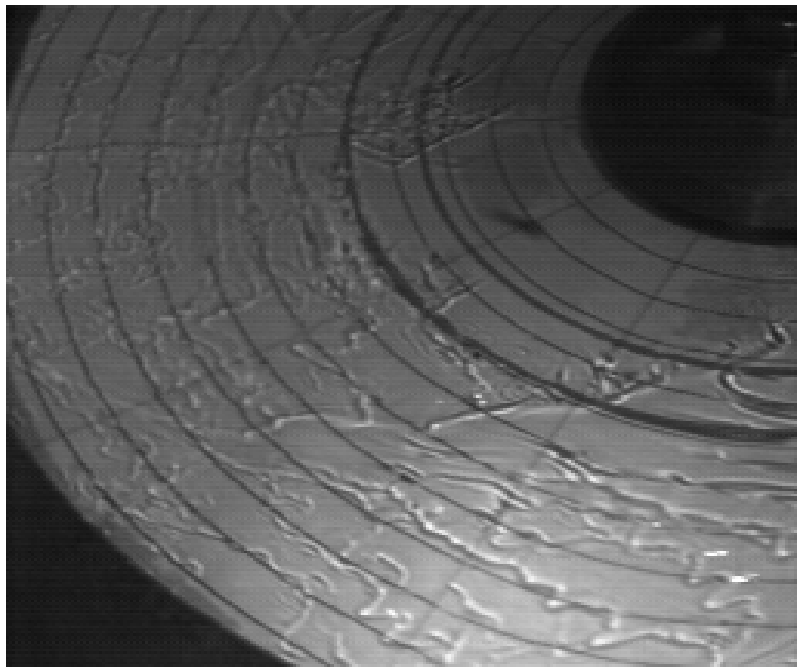
SDR operating principles

- Rotation of disc surface creates high centrifugal fields which promote thin film flow
  - Film thickness typically 50-500 μm
- Films are highly sheared and have numerous unstable surface ripples, giving rise to intense mixing
- SDR has been successfully applied to a range of processes which are micromixing dependent:
  - Polymerisation
  - Crystallisation
  - Competitive organic reactions



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SDR micromixing characterisation

- Test reaction studied:

$$H_2BO_3^-{}_{(aq)} + H^+{}_{(aq)} \Leftrightarrow H_3BO_{3(aq)}$$ **Quasi-instantaneous Acid-base neutralization**

$$5I^-_{(aq)} + IO_3^-{}_{(aq)} + 6H^+_{(aq)} \Leftrightarrow 3I_{2(aq)} + 3H_2O_{(aq)}$$ ***Dushman reaction, fast***

$$I_2 + I^- \Leftrightarrow I_3^-{}_{(aq)}$$ **Quasi-instantaneous**

- Concentration of tri-iodide estimated using UV-Vis Spectroscopy and Beer-Lambert law

$$\left[I^-{}_3\right] = \frac{D_\lambda}{\varepsilon_\lambda \times l}$$

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SDR micromixing characterisation

- Measures of micromixing efficiency:
  - *Segregation index, Xs*

Defined as the actual yield of the undesired product, Y compared to its maximum yield, Yst:

$$X_S = \frac{Y}{Y_{ST}}$$

Perfect micromixing: $X_S = 0$,
Total segregation: $X_S = 1$,
Partial segregation: $0 < X_s < 1$

- Effect of the following parameters on micromixing efficiency assessed in SDR:
  - Disc speed
  - Feed flowrate
  - Feed viscosity
  - Acid concentration

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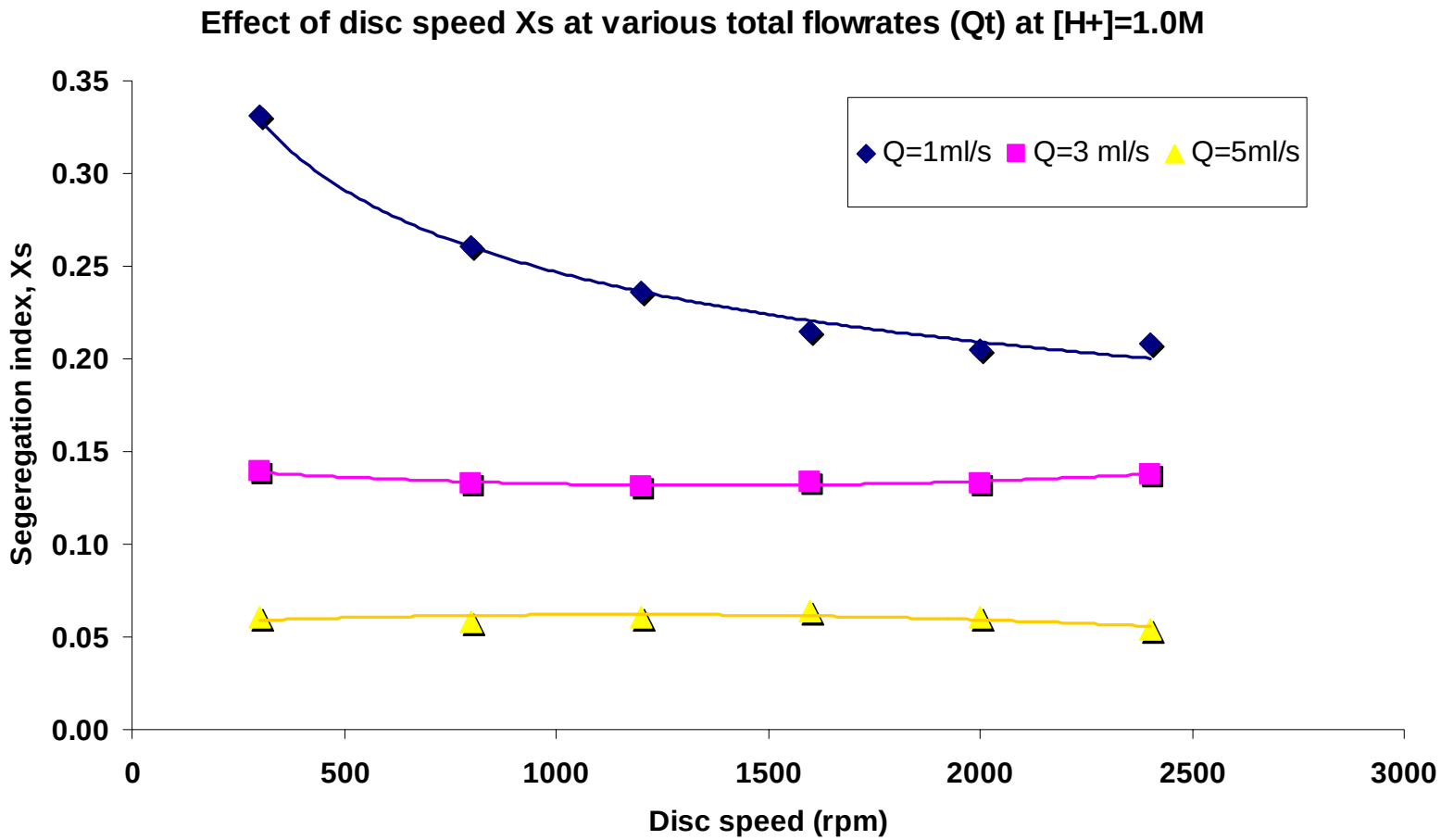
Effect of disc speed and feed flowrate on Xs



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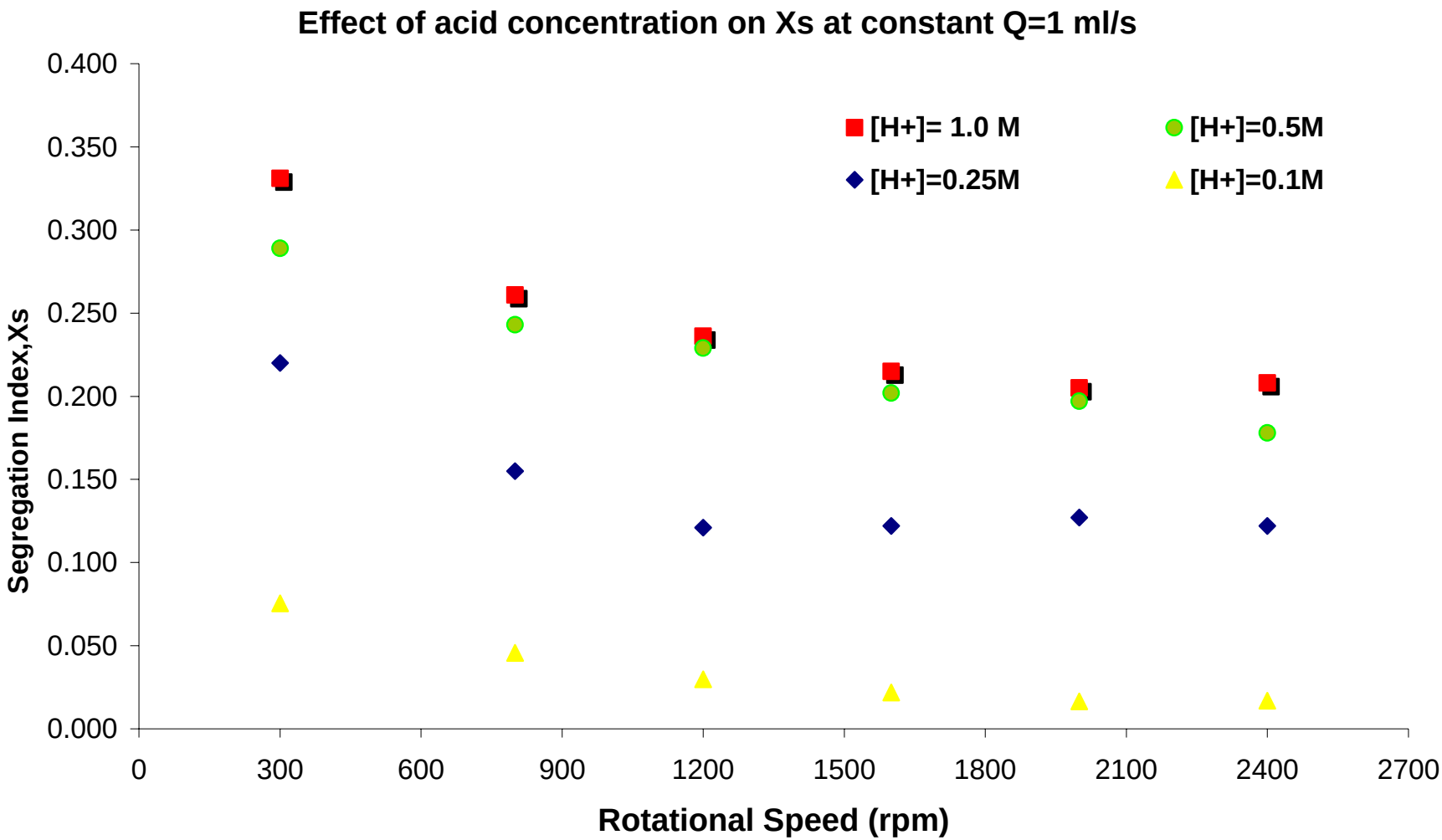
Effect of acid concentration on Xs



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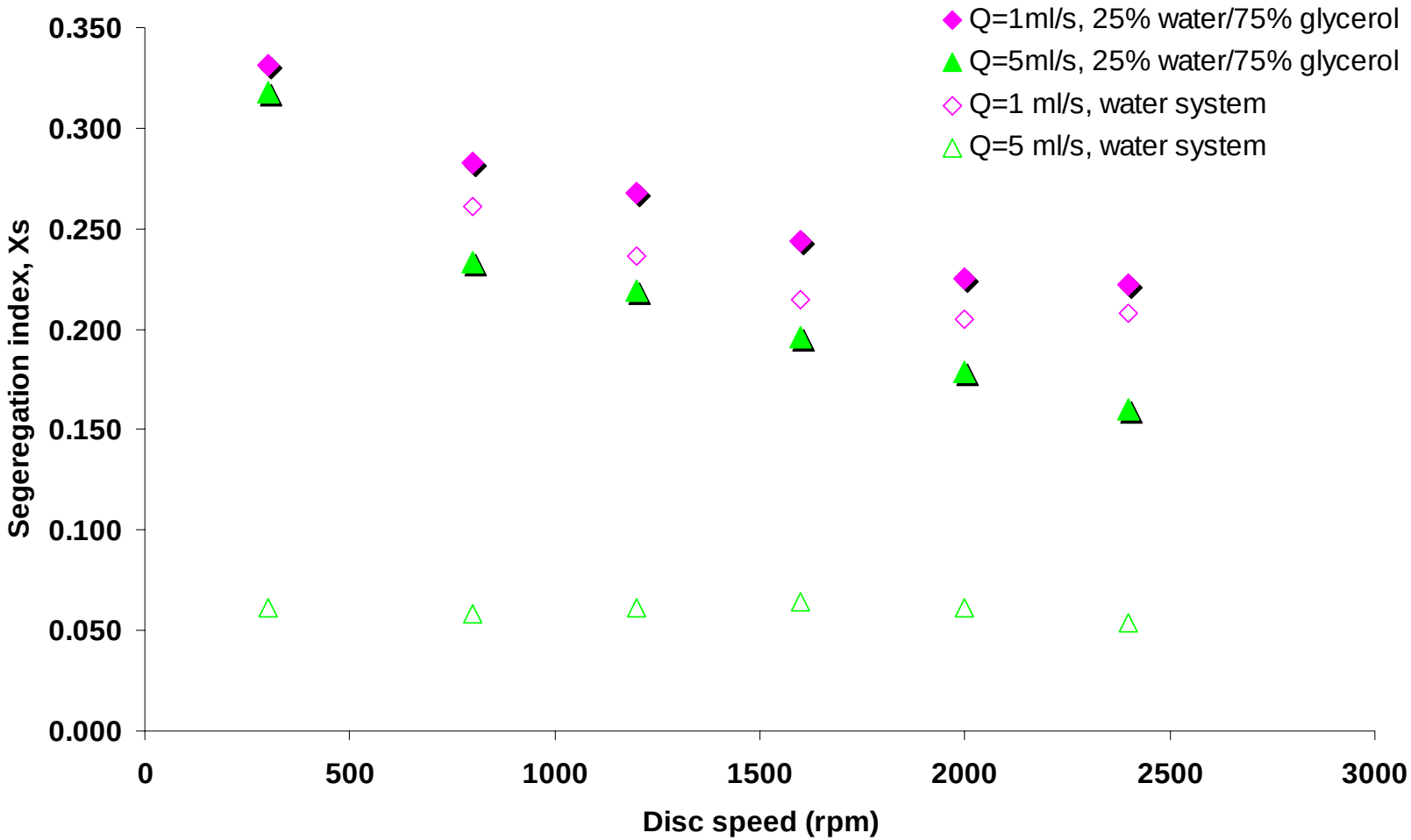
Effect of feed viscosity on Xs in SDR



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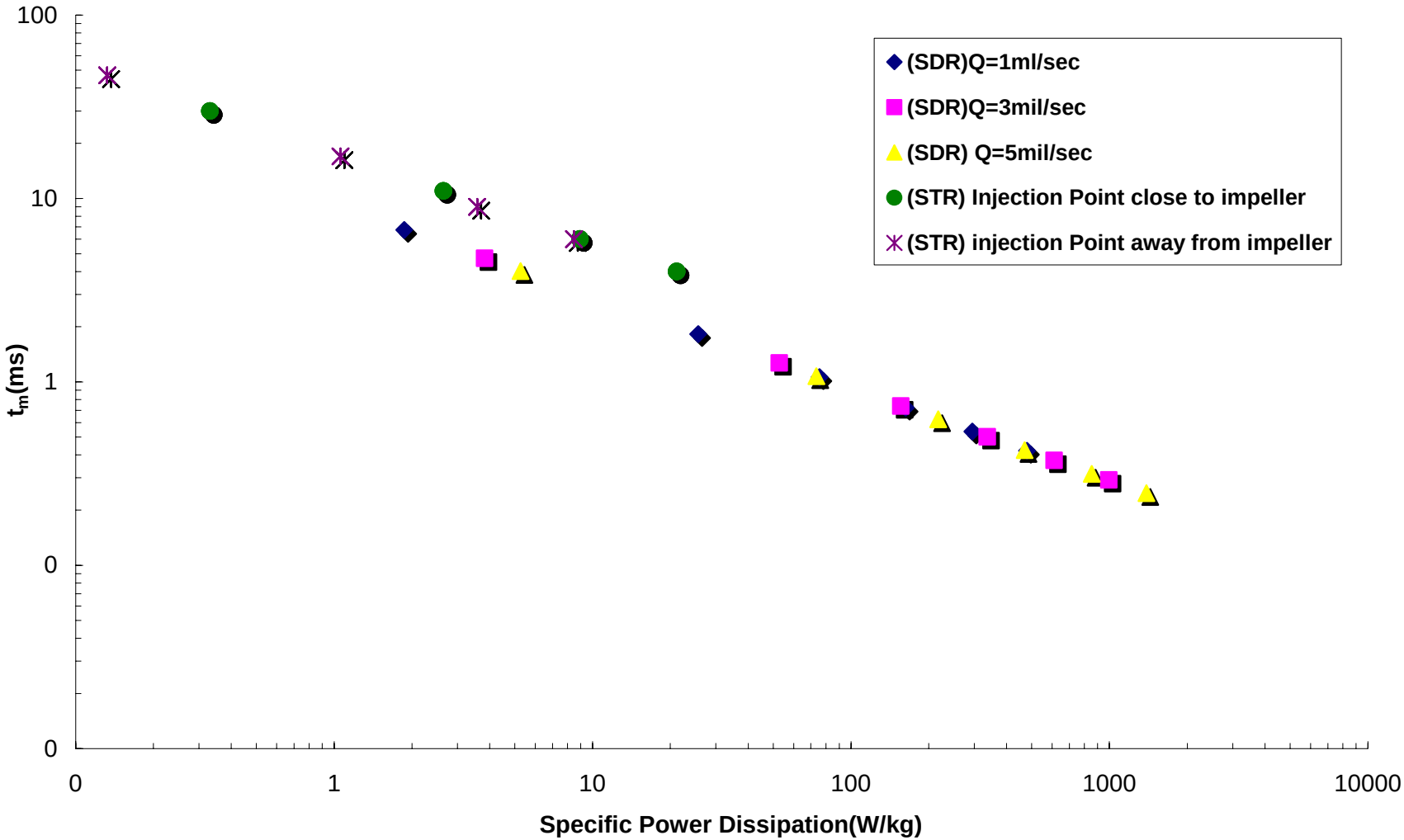
Micromixing time: SDR vs. STR



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Summary

- Disc speed, feed flowrate and feed viscosity are highly influential parameters in micromixing process in SDR
- Lower micromixing time is achieved in SDR than in conventional STR, resulting in improved product quality (e.g crystal size distribution and molecular weight distribution)
  - This is related to higher power dissipation generated in SDR

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Questions?