**Design of a Microreactor for Microwave Organic Synthesis through Microwave Heating Simulations**

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**Goal:**

To design a microreactor for a microwave unit in order to achieve:

- High-throughput organic synthesis, reaction screening
- Kinetic modeling of microwave reactions

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**Original Design:**

- 1.4 mm thick
- Channels: 150 μm
- Material: borosilicate

**Heating Issues:**

- Uneven temperature distribution across reactor; center of the reactor is hottest.
- Maximum steady-state temperatures too low for desired chemical reactions

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**Computational Model:**

- The RF module: microwave heating and electromagnetic waves physics

\[ \nabla \times \mu_r^{-1} (\nabla \times E) - k_0^2 \left( \epsilon_r - \frac{j\sigma}{\omega\epsilon_0} \right) E = 0 \]

\( \rightarrow \) solve electric field
\( \rightarrow \) heat source: \( Q = \frac{1}{2} \omega \epsilon_0 \epsilon' \cdot E \cdot E^* \)

- Single-Phase Flow Module:

\[ \nabla \cdot v = 0 \]

\[ \rho \frac{Dv}{Dt} = \rho g - \nabla P + \nabla \cdot \tau \]

\( \rightarrow \) velocity of air convection in waveguide

- Heat Transfer Module:

\[ \rho c_p \left( \frac{\partial T}{\partial t} + v \cdot \nabla T \right) = \nabla \cdot (k \nabla T) + Q \]

\( \rightarrow \) solve for temperature

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**Results:**

- Surface BC: Natural Convection
- Microwave waveguide and cavity: air convection
- Magnetron: 2.45 GHz, Max power: 300W

**Conclusion:**

The simulation results match the measurements and uneven temperature distribution. The heating issues were caused by low electric field strength, which varies with the size and position of the reactor. A higher electric field strength could be induced by redesigning the reactor thickness.

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