Fast micromixer in a non-uniform AC electric field

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Abstract

Microfluidics based microreactor offers several advantages: high surface to volume ratio for fast heat transfer to significantly reduce the potential for dangerous adverse reactions in highly exothermic reactors; it can avoid scaleup to accelerate the developing phase of a new product. However, the mixing is relatively slow in a microchannel, where the Reynolds number if low and flow is laminar, thus the molecular diffusion is the main mechanism for mixing. Although many new mixers for microfluidics have been developed in last decade, there are still many challenges need to be solved. Here we present a new micromixer based on AC electrokinetics in a nonuniform electric field.

We fabricated a quasi T microchannels with electrodes on the sidewall to enhance mixing with AC electrokinetics. A parametric study was conducted to explore the effectiveness of manipulating electric field to enhance fluid mixing inside the microchannel channel. Firstly, mixing results in two cases with different management of electrodes have been compared: electrodes are placed at the sidewall and electrodes are located at the ends of the channel. It is fund that the former is more efficient for mixing enhancement at the save voltage. Secondly, the mixing performance in the microchannel with different angle between the two electrodes was assessed in terms of scalar concentration distributions. There seems to be an optimized angle, at which the mixing is fastest. Thirdly, the effectiveness of the applied voltage phase variation between the two electrodes on the mixing process inside the quasi T channel was also explored for the further mixing enhancement. Fourthly, mixing result under high frequency was also achieved to avoid bubble generation, a key issue in DC electrokinetics based micromixer. Finally fluorescent particles in one of the two streams were used to obtain a more clear visualization of mixing process in the microchannel with 5° angle between the two sidewalls. We find that this new designed micromixer can cause fast mixing at low voltage.

keywords: Micromixer, AC electrokinetics, mixing enhancement.

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Please specify whether you wish to be considered for an oral x□ or poster □ presentation.

Do you anticipate submitting a full paper to the special Mixing issue of the Canadian Journal of Chemical Engineering? Yes