새로운 CSC micromixer 를 이용한 유동가시화

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Flow Visualization in a new CSC micromixer

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Abstract

The paper reports on a new type of combinatorial chaotic and serpentine micromixer. Such a new and novel micromixer is simple to fabricate and easy to use. The micromixer is characterized and visualized with the help of the Micro-LIF technique. The new micromixer will e further applied to lab-on-chip device. The mixing capabilities of this mixer is about 30-33%.

Key Words : 국문과 영문 병기(예: Flow Visualization(유동가시화), micro-mixer(마이크로믹서), Micro-llF

기호설명(선택사항)

여기에 기호 설명을 입력하시오

1.Introduction

Micromixers play a significant role in micro chemical processing and are employed in a multitude of tasks, including blending, emulsification and suspension, as well as for chemical reaction and also in combination with integrated heat exchangers. Due to the small dimensions of the micro channels, the flow is predominantly laminar and mixing is therefore limited by molecular diffusion. In order to effectively mixing a reasonable time, fluids must be manipulated so that the interfacial surface area between the fluids is increased massively and the diffusional path is decreased, enhancing the molecular diffusion to complete the mixing process (Ehrfeld et al., 2000). In the present study, a new combinatorial micromixer has been visualized using Micro-LIF technique.
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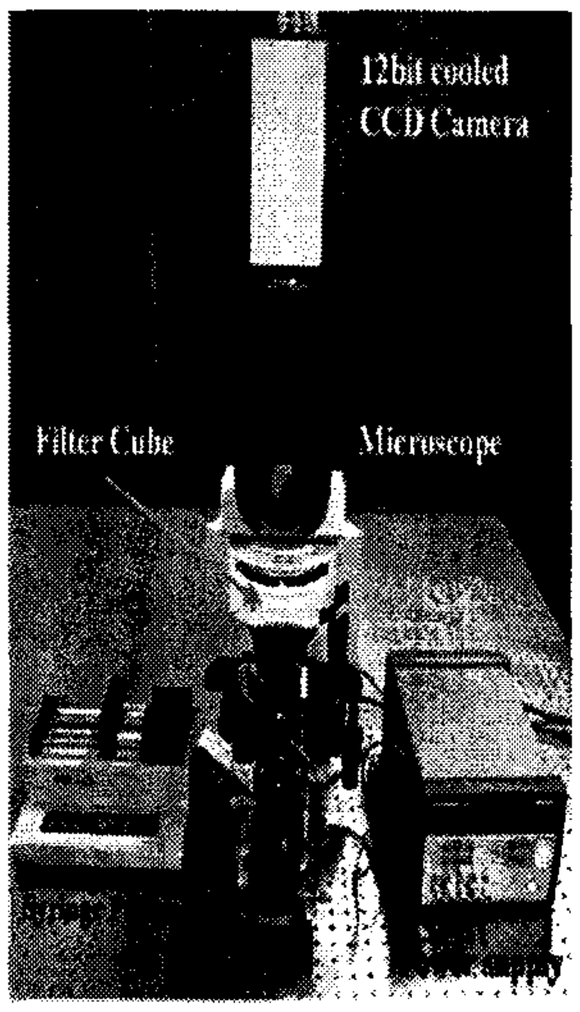
2.Experimental

The performance of the micromixers was tested by mixing solutions and the flow profile was visualized by using fluorescent dyes. Micro-LIF (micro-scale laser induced fluorescence) technique was used for flow visualization to confirm the performance of the CSC mixer. The experimental set-up arrangement was similar to previously reported work as shown in Fig. 3(a). The developed micro-LIF system consists of a 12-bit cooled charged coupled device, CCD camera (1,280 X 1,024), a microscope equipped with a long pass filter, and syringe pumps (Yoon and Kim, 2006). To reduce measurement errors due to dark noise, a Peltier-cooled CCD camera has been used. An appropriate fluorescence dye had to be selected for best matching with the 532 nm laser wave as an absorption band. The candidate fluorescence dyes were Rhodium B (Sigma, USA). Rhodamine B was used for enhancement of fluorescecent intensity with the relatively wide separation between the absorption and emission bands, the emission band filtering can be more discrete. The base color of Rhodium B is pink in the day light, whereas it emits orange at 565 nm when the laser absorption is taking place at 532 nm peak.

A long pass filter with 545 nm cut-off was used to block out the illuminating laser light with peak intensity at 532 nm. The fluorescence light at 565nm wavelength passes through the filter with 90% of transparency ratio, while the illuminating laser light of 532 nm is completely eliminated with less than 0.01% of transparency ratio (Yoon, 2006)

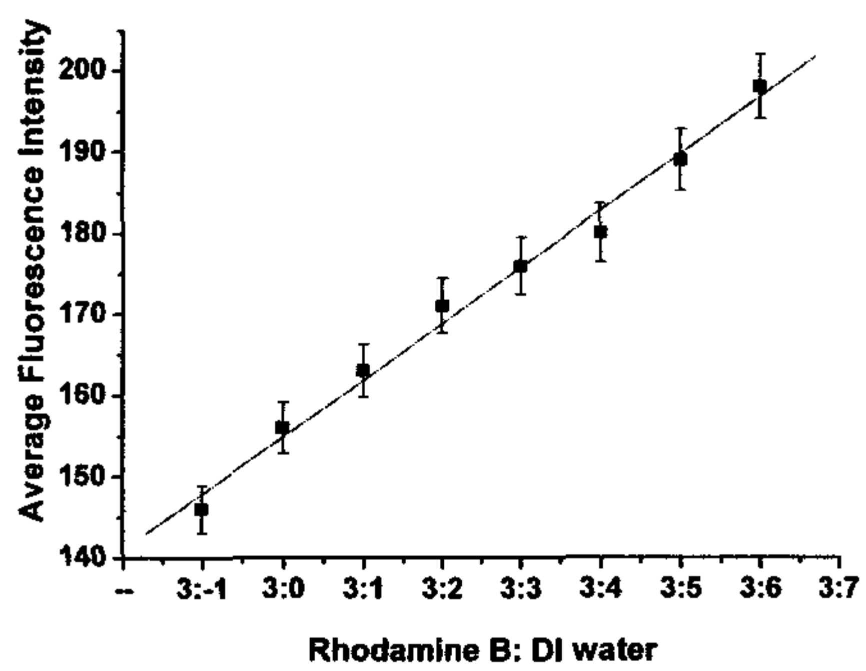
One standard solution with 10mg of Rhodamine B and 20ml of DI water was prepared. Then various aliquots at of Rhodamine B solutions were prepared at different dilutions (3:-1 to 3:6) from the standard solution. The syringe-pump was used for inserting the solutions. After setting-up the Micro-LIF arrangement, as shown in the Fig4, 20 images were captured by focusing the camera.



3.Results and Discussions

Previous experimental results done by Maha have shown that higher concentration Rhodamine B fluorescent solution (1.44x10^{-5} M) resulted in non-linear behavior between intensity distribution and concentration which was explained due to inner filter effects (decrease in emission quantum yield as a result of re-absorption of emitted radiation). A new solution of lowest concentration was prepared and calibration experiments performed by preparing ten different solutions varying the concentration by 10%. Each solution is pumped into the micro-channel and images (20 images at each location) are taken at different locations starting from the first jet on the micro channel by moving the microscope stage by 200μ m until the second jet and some image sets in the mixing channel. Images are taken using a 40X air-immersion objective from Olympus using 4X4 binning on the pixels. Camera settings are maintained constant for all the images taken for different concentrations. These images are post-processed to plot the curve between average intensity of Rhodamine B solution and concentration variation (dilution). A linear variation between average intensity and dilution is found from the post processing results as shown in the Fig.2.

Fig. 3 illustrates the mixing effect in the images of the microchannel at selected cross-sections, along the channel walls and the CSC mixer, as observed in the Micro-LIF technique. The gray scale intensity distribution is shown in the Fig… white colour is for the Rhodamine B and the dark gray color is for concentration of DI water with the fixed concentration in ratio of 3: 4 and flow rate is 10μL s^{-1} which was previously optimized. In Fig. 3 shows the where the darker is the DI water



(a) (b)

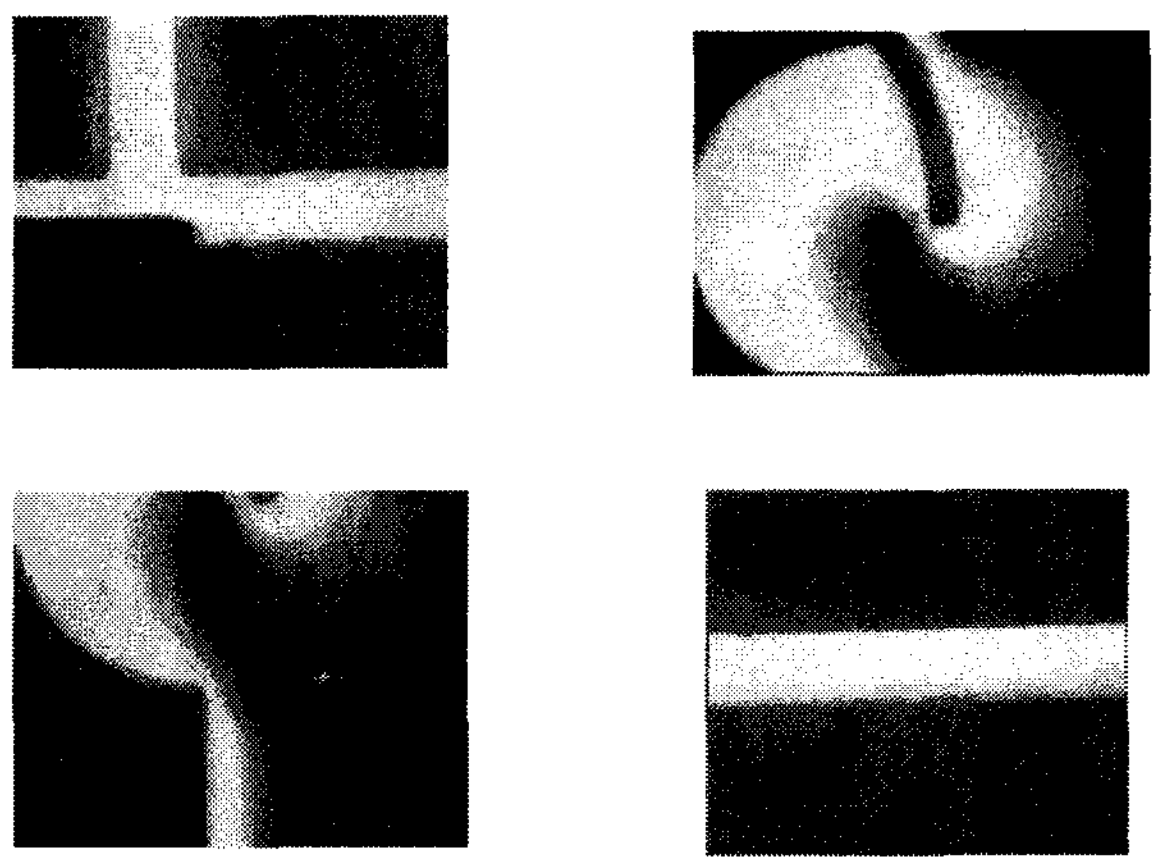


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Fig.3. Visualization of mixing effect using Micro-LIF (a) Junction of the inlets, (b) First CSC micromixer in the microchannel (c) outlet CSC micromixer in the microchannel (d) Outlet with fully mixed solutions

3. Conclusions

A new type of CSC micromixer has been successfully designed , fabricated and visualized for the application of lab-on-chip device. The mixing efficiency of the micromixer is foumd to be 30-33%. The new and novel micromixer is easy, has better mixing using LTM concept of chaotic advection. The micromixer is also applied to the LOC device.

여기에 결론을 입력하시오

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