Static mixing for a uniform layer distribution and easy fabrication

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Static Mixing for a Uniform Layer Distribution and Easy Fabrication

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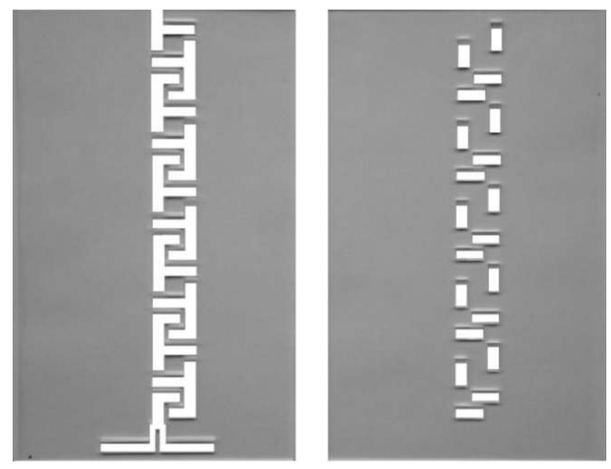


Introduction

Static mixers to mix fluids at near-zero Reynolds numbers are frequently based on repeated transversal interface cutting, stretching, rotating and stacking operations. These operations (Figure 1) are feasible in simple cavities between two plates, see poster top right.

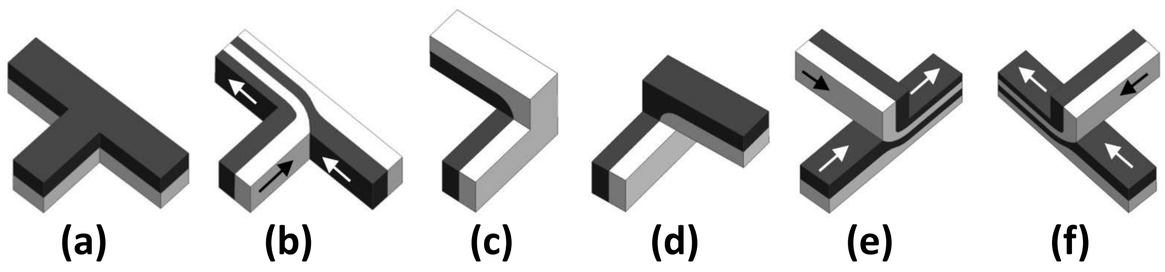


Figure 1: *Horizontal splitting (stretching) (a), horizontal combining (stretching) (b), left (c) and right turning (d), right turning and vertical combining (e) and left turning and vertical combining (f).*

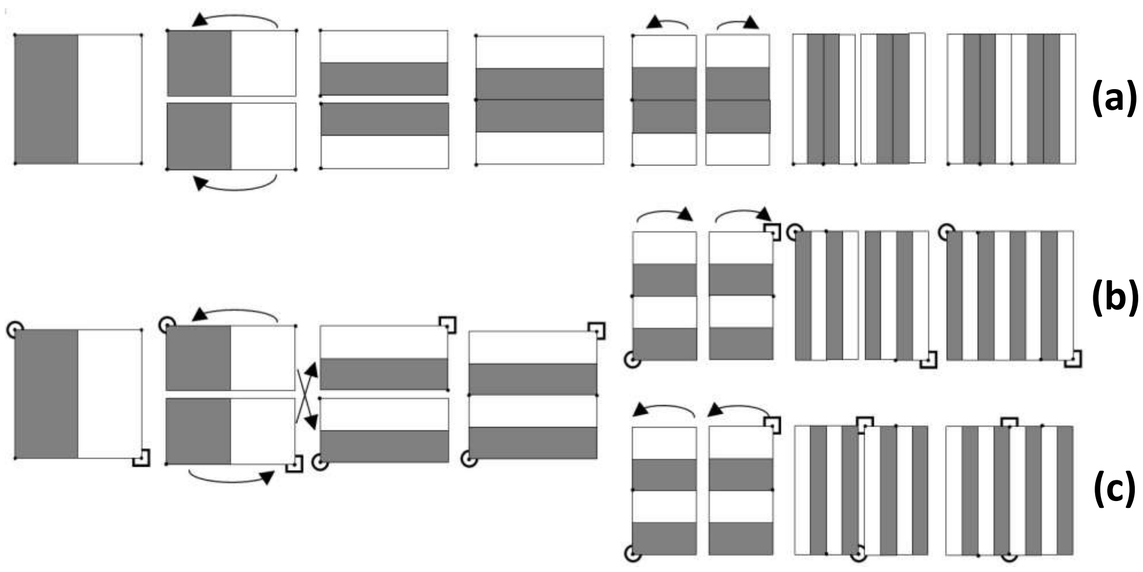
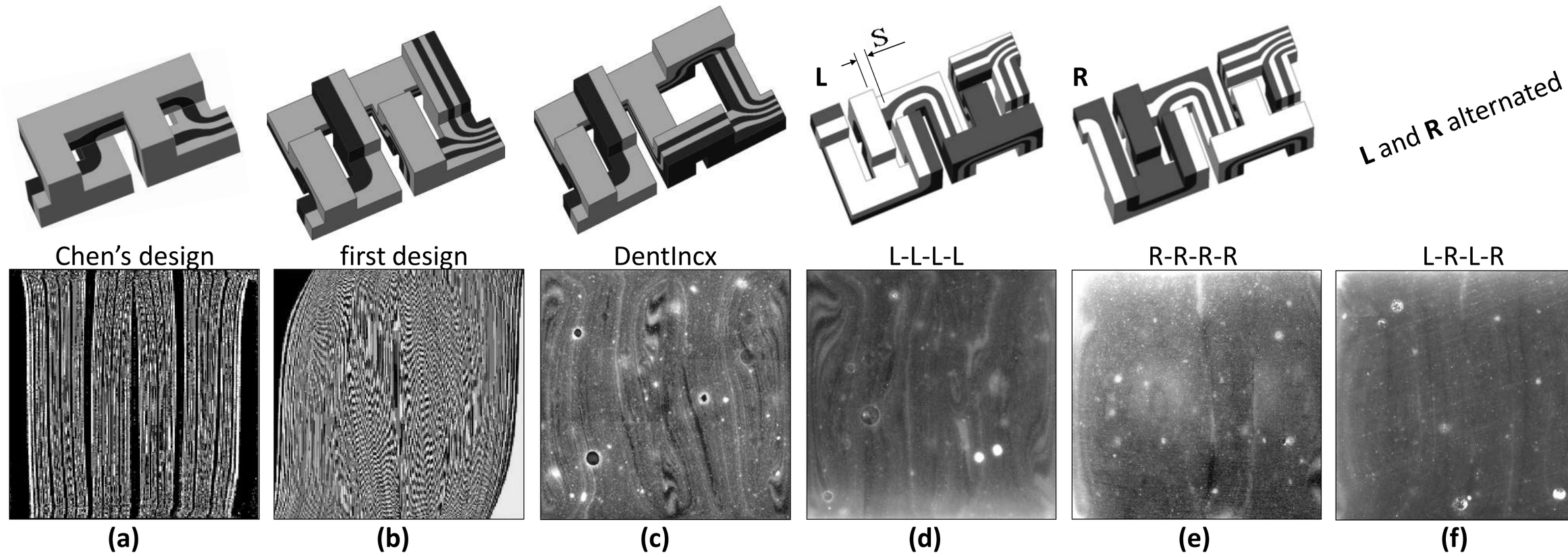


Figure 2: *Details of the layer and corner point redistribution. Chen's design (a), our first design (b) and second design "the DentIncx" (c).*

Design and Experiments

After splitting, in Chen's design (Figure 3a) the parallel channels are counter rotated which recombines layers of the same material in the middle of the channel leading to an uneven distribution in layer thickness, see Figure 2a, and only 257 layers after four elements. In our first design, Figure 2b and 3b, layer distribution is improved by preventing "counter rotating", although bad mixed corners occur, it produces 512 layers after four elements. In the second design, "the DentIncx", this is solved by rotating flows away from the corners, Figure 2c and 3c, which results in better mixing, apart from a few spots on the vertical centerline. This is coursed by crosstalk between rotating and vertical splitting or recombining operations (Figure 1e and 1f). Using horizontal splitting and recombining operations, like in Figure 1a and 1b, create more distance between operations, see "S" in Figure 3d. This approach results in two types of mixers which are only different in entrance rotation of each element, as shown in Figure 3d and 3e: **L** for a left rotating entrance and **R** for right rotating entrance. Figure 3d and 3e show the cross-sectional view after four elements of type **L** and **R** which still have a unsatisfying layer distribution. Fortunately, an alternating combination between the two types (**L-R-L-R**) improves the layer distribution tremendously, see Figure 3f.



Figuur 3: *One mixer element of each design (top) and cross sectional views after four mixing elements by computed mapping [2] of Chen's mixer [1] (a) and our first design (b) and experiments (performed with two differently colored two-component epoxies) of our second design "the DentIncx" (c) and designs based on horizontal splitting and recombining, L-L-L-L (d), R-R-R-R (e) and L-R-L-R (f).*

References

[1] Chen H., Meiners J.C., *"Topologic mixing on a micro fluidic chip"*, Applied Physics Letters.

[2] Singh M.K., Anderson P.D., Meijer H.E.H., "*Understanding and Optimizing the SMX Static Mixer".*