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Experimental and numerical investigation of the three-dimensional flow in a T-shaped micromixer. RALPH LINDKEN, JEANETTE HUSSONG, JOEP VAN ESCH, JERRY WESTERWEEL, Delft University of Technology — Three-dimensional stereoscopic-micro-PIV measurements reveal the symmetry breaking of the laminar stationary flow in a symmetric micro-scale T-shaped mixer. Liquid flows from both side arms into the T-mixer, meets in the junction region and enters the mixing channel under a 90-degree flow direction change. At a geometry-dependent Reynolds number of about 140 the flow pattern changes from parallel co-flow to a complex three-dimensional flow pattern. The mixing process changes from diffusion only to advection with mixing times of less than 1 ms. CFD simulations show that for undercritical Reynolds numbers the parallel co-flow is dominated by two Dean vortex pairs. At the critical Reynolds number the flow pattern changes from four Dean vortices to two stationary co-rotating vortices in the mixing channel. The interaction of the corner vortices in the junction region and the Dean vortex pairs results in an engulfment process of the entering liquid streams that causes the change of the flow pattern. The overcritical flow pattern has two stable symmetric solutions. The existence of this bifurcation is proven numerically. The novel laminar bifurcation is also verified experimentally.

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