Flow focusing in microchannels

*Malcolm R. Davidson [1], Dalton J.E. Harvie [1] and Justin J. Cooper-White [2]

[1] The University of Melbourne, Melbourne, Australia
[2] The University of Queensland, Brisbane, Australia

The continuous manufacture of emulsions which have defined micron-scale droplet sizes are paramount to the successful market acceptance of many products within the food, cosmetic, pharmaceutical and photographic industries. An understanding of the deformation history and breakage of drops of one liquid within another liquid is thus of vital importance. Flow focusing of a continuous stream of liquid is one way of creating such drops. The method offers a high degree of control over the velocity gradients experienced by the fluid to be dispersed and is suitable for use at the micron scale. Very few studies have been published on flow focusing and there appears to be no numerical modelling of it. In this paper, numerical simulations of 2D axi-symmetric flow focusing are undertaken for conditions approximating those of the 3D flow in recently published experiments. The calculations are performed using a Volume-of-Fluid finite difference technique. The predicted drop formation is compared with the experimental results at various flow rates, and the mechanisms of drop formation in this context are discussed. A high degree of qualitative correspondence is found between the numerical and experimental results.