Highligths:

1. We model Bretherton flow in microchannels with rectangular cross sections by the diffuse interface model
2. Bubble can have axisymmetric and non-axisymmetric shape depending on the capillary number
3. The lattice Boltzmann method (LBM) free-energy binary liquid model was chosen as a framework for the diffuse interface model
4. Results show that uniform density LBM free-energy binary liquid model is able to capture all phenomena indicated in literature as bubble shape change from non-axisymmetric shape to symmetric, existence of the vortex in front of a bubble, non-dimensional relative to liquid velocity of the bubble