Fluid interfaces provide unique opportunities for microfluidic and nanofluidic systems. Applications range from microscale heat exchangers and miniature fuel cells to microreactors for materials synthesis. Multiphase flow in such devices can be challenging, as the interfacial forces naturally favor axisymmetric geometries that are difficult to microfabricate. The advantages of surface tension dominated microfluidics include a much richer dynamic flow behavior and enhancement of heat and mass transfer by creating secondary flows. These advantages offer many uses beyond enabling gas-liquid and fluid-solid reactions [1].

In particular, we are interested in segmented flow of gas and liquid in hydrophilic channels. Figure 1 shows several key features of this flow for reaction purposes. The presence of bubbles reduces the amount of dispersion of liquid flowing through the channels, ensuring that reactants and products spend a uniform amount of time in the system. For nanoparticle synthesis in microfluidic networks, a uniform residence time distribution translates into narrowly distributed particle sizes [2-3]. Liquid segments are efficiently mixed by circulation motion and gas bubbles are separated from microchannel walls by only a thin film (thickness < 1 µm). Thin films reduce mass transfer resistance to components immobilized on the walls, such as catalysts [4] or analytical reagents and antibodies. We are also interested in the dynamics of multiphase flow through microchannels that are populated with a forest of micropillars (diameters: 50 µm – 100 µm). The observed flow patterns (Figure 2) connect to fundamental studies of flow in porous media and to catalysis. Gas-liquid and liquid-liquid flow patterns and their dynamics are determined in pulse-laser fluorescent micrographs and with microscale particle image velocimetry (PIV) measurements. Characteristics of such three-phase systems, such as persistent static fractions, axial dispersion and mixing, are compared with multiphase flow in macroscopic unstructured beds and porous media.

**REFERENCES**


