Air-Liquid Two-Phase Flow in Microchannels

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Sub-millimeter thin channels were used to investigate the flow patterns of two-phase air-water flow. The channel dimensions were 10 mm wide and 100 mm long with a thickness ranging from nominal 1 to 0.25 to 0.125 mm. Pressurized air was mixed into the water in a T Joint before it entered the microchannel. Fluorescent dye was mixed into the water and illuminated with an NdYLF laser. The flow patterns were captured with a high-speed video camera. Water and air flow rates ranged from 20 to 950 cm^3.

The flow patterns are identified as bubble, cap, annular, churn, and plug flow. In bubble flow, round shaped bubbles were observed. Example images of the flow patterns will be presented as pictures. The cap flow is characterized by half-moon-shaped bubbles. In the annular flow pattern, a continuous air stream is formed in the center of the channel and is surrounded by water. The plug flow consists of smooth and irregularly shaped bubbles. Churn flow is characterized by rough air liquid boundaries.

The transition from one flow pattern to the next depends on the channel thickness and flow rate. The observed flow patterns in the 1-mm channel are primarily bubble flow followed by plug flow and annular flow with increasing air flow. The change of flow patterns occurs at higher air flow rates when liquid flow rates are increased. Annular flow has not been observed at high liquid flow rates.

In the 0.25 mm channel, the flow patterns changed from cap flow to plug flow and to churn flow at high water flow rates. At the 0.125 mm channel, only a transition from plug flow to churn flow was observed. Air and liquid flow rates at which flow pattern changes occurred are identified and reported.