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Bubbles in piezo-acoustic inkjet printing

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Ink-jet printing is considered as the hitherto most successful application of microfluidics. A notorious problem in piezo-acoustic ink-jet systems is the formation of air bubbles during operation. They seriously disturb the acoustics and can cause the droplet formation to stop. We could show by a combination of acoustical detection and high-speed visualization that the air-bubbles are entrained at the nozzle and then grow by rectified diffusion.
Experimental results on the droplet velocity as a function of the equilibrium radius R0 of the entrained bubble are presented, too. Surprisingly, the droplet velocity shows a pronounced maximum around R0=17 micrometer before it sharply drops to zero around R0=19 micrometer. A simple one-dimensional model is introduced to describe this counterintuitive behavior which turns out to be a resonance effect of the entrained bubble.
We show that the bubble counteracts the pressure buildup necessary for the droplet formation. The channel acoustics and the air bubble dynamics are modeled. It is crucial to include the confined geometry into the model: The air bubble acts back on the acoustic field in the channel and thus on its own dynamics. This two-way coupling limits further bubble growth and thus determines the saturation size of the bubble.