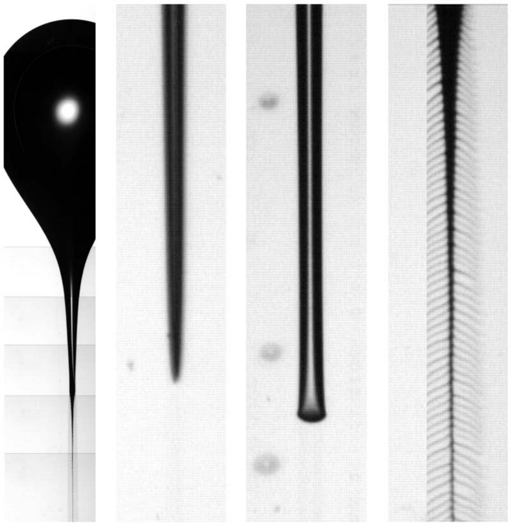

FIG. 1. Bubble with a "fish backbone pattern" and cusps for bubbles with volumes of 155, 197, and 268 mm^3 (from left to right).

Breakup of the tail of a bubble in a non-Newtonian fluid

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The so-called tip-streaming phenomenon has been reported by several authors (starting with Taylor[1] and, more recently, Eggleton *et al.*,[2] among others). Daughter drops are ejected from a thin thread at the tip of a highly stretched drop (under mixed shear and extensional flow).[3] We have observed similar phenomena at the rear of an air bubble moving in a non-Newtonian fluid (Figs. 1 and 2). The fluid for which we have observed this phenomenon is an aqueous solution of an associative polymer[4] (hydrophobically modified alkali swellable acrylate) with 0.02 wt % sodium salicylate.

In the case of a single air bubble rising in the solution for volumes above a critical volume (~80 mm^3), a cusp appears at the rear of the bubble. Figure 1 shows the cusps for volumes of 155, 197, and 268 mm^3. First, a wide shot of a bubble is presented (left). Then, a zoom of three different tails is shown. In the first case, the cusp is axisymmetric. Increasing the volume, the cusp becomes asymmetric with a "knife-edge" shape. In the third case, the tail breaks in a "fish backbone" pattern. In Fig. 2, sequences of images for volumes of 523, 718, and 955 mm^3 are presented. The cusp changes drastically and breaks in multithread patterns. Once the bubble passes by the tested region, residual air microbubbles lie behind and they serve as fluid tracers. As the fluid relaxes, several patterns are observed. Although the influence of the fluid structure and elasticity is evident, we do not yet have a full understanding of these observations.

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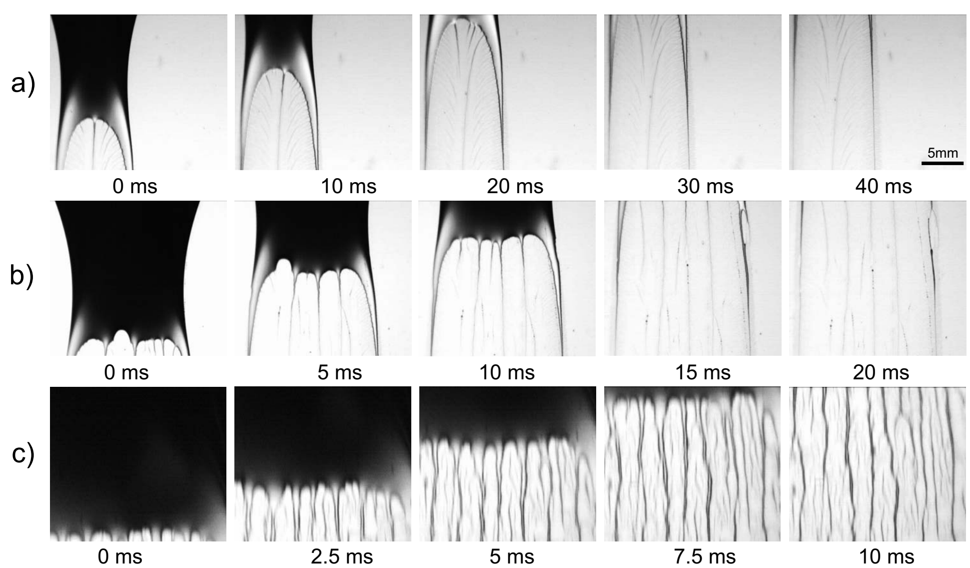

FIG. 2. Image sequences of air bubble tails with volumes of 513, 718, and 955 mm^3, respectively. The scale is the same in all cases. (a) The tail breaks in two "fish-backbone" patterns and some threads split in the region between them. (b) The tail becomes wider than in the previous case, following a similar pattern. The same tail pattern remains after 20 ms. (c) For the largest volume, the tail further widens and breaks into a multithread arrangement (enhanced online).

