Collective bubble collapse dynamics in a foam

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ABSTRACT

Liquid-gas foams, which are composed of gas bubbles and liquid films, have disordered cellular structure. They exhibit unique properties, making them distinct from ordinary fluids and solids. They are widely seen in daily life, from foods and beverages to pharmaceuticals, cosmetic products, cleaning products amongst many other applications [1]. The foam is a metastable non-equilibrium state and eventually collapses as time elapses. During the collapse of foams, a burst of a bubble can provoke racking of neighboring bubbles. This phenomenon is called collective bubble collapse (CBC). Although CBC plays an important role in foam stability, the mechanism behind CBC is still unclear.

In our study, we experimentally reveal the mechanism behind CBC. We directly observe the CBC phenomenon by using a high speed camera. It was found that there were two modes for the CBC. One is the propagation mode, which means the liquid-film breaking due to the impact of absorption (larger red dashed circles a in Fig. 1). The other is the penetrating mode, when liquid droplets are emitted due to the impact of absorption and penetrate through other, distant liquid films (arrows and smaller dashed circles b and c in Fig. 1) [2]. Furthermore, we investigate the process of liquid-film breakage during the CBC in detail, and find that it shows interesting behavior attributable to characteristic structure of a foam, which is different from the rupture of a single bubble. We also show how the droplets are created during the CBC [3].

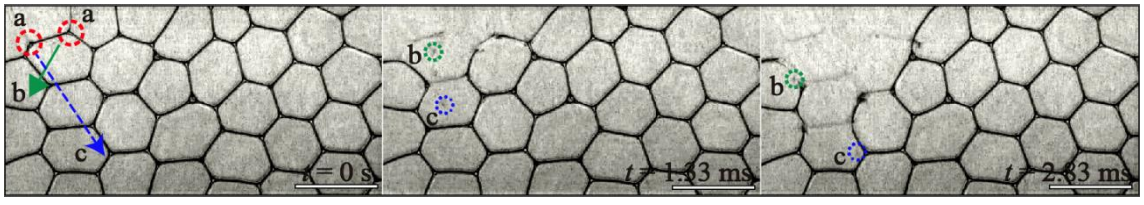

Figure 1: Enlarged successive images of the collective bubble collapse (CBC). The white bar corresponds to 5 mm.

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