

The physics of an acoustic microscope using bubbles

The context Bubbles in water behave as very good oscillators, with a strong acoustic resonance. Their environment influences the resonance frequency; for instance, it decreases near a solid surface. Recently, our laboratory has developed a technique to stabilize bubbles by trapping them in solid cages made by precise 3D printing, see figure (a) and (b). We have shown that bubbles can still vibrate widely in these structures under acoustic excitation, while having a lifetime of several days! As such, bubbles are therefore good candidates to probe the surroundings, and to make an image of the properties of a surface by scanning above a sample. This is the concept we introduced as B-SNAM, for Bubble Scanning Near-field Acoustic Microscopy, see figure (c).

Objectives The main objective of the internship is to understand the physics of “acoustic sensing” with a bubble, i.e. using a bubble to detect the presence of nearby materials and measure their elasticity. In a first step we propose to design a 3D cage to hold bubbles that are suited for a local measurement of the surroundings, by monitoring the vibration properties of bubbles. In a second step we will develop the theoretical and experimental tools to detect the presence of solid boundaries, and also to probe the elasticity of the solid. In a last step, we will elaborate on the interaction of multiple bubbles, and how the environment modifies the collective properties.

Outcomes We aim at creating novel acoustic sensors based on bubbles, with applications in medicine, industry and exploration in opaque fluids.

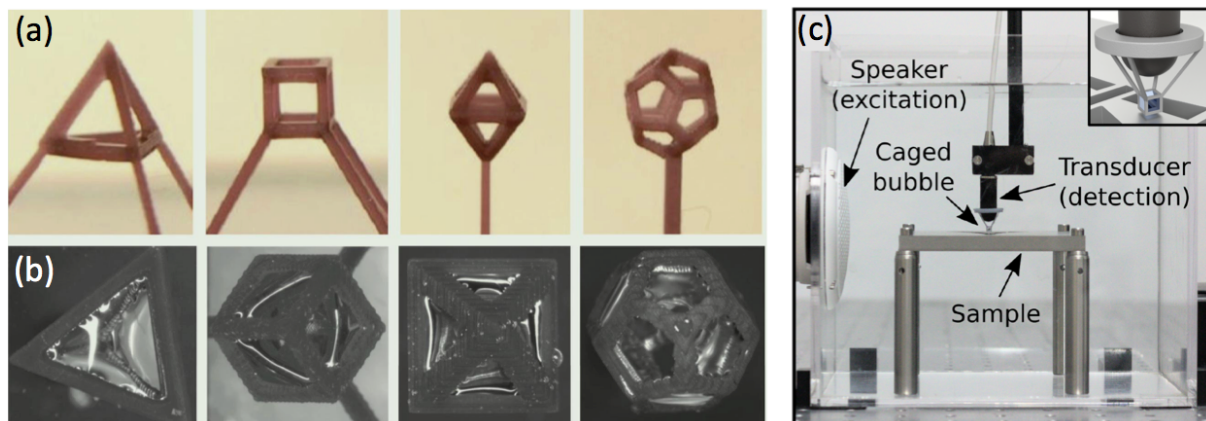


Figure (a) 3D-printed cages of 3-mm-wide polyhedra. **(b)** Trapped bubbles, after immersion of the cages in water. **(c)** Set-up to image a sample by scanning the surface with a caged bubble.

Environnement Laboratoire Interdisciplinaire de Physique is located on the Grenoble campus, France.

Supervision The trainee will work in a team with Philippe Marmottant (acousto-fluidics and microfluidics), Benjamin Dollet (theory), Olivier Stephan (3D manufacturing) in collaboration with Emmanuel Bossy and Dorian Bouchet (acoustic sensing and imaging).

PhD grant The internship can be continued in a PhD, since we can provide a PhD grant through the ANR B-SNAM.

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