Optimizing structures within complex arrangements of bubbles

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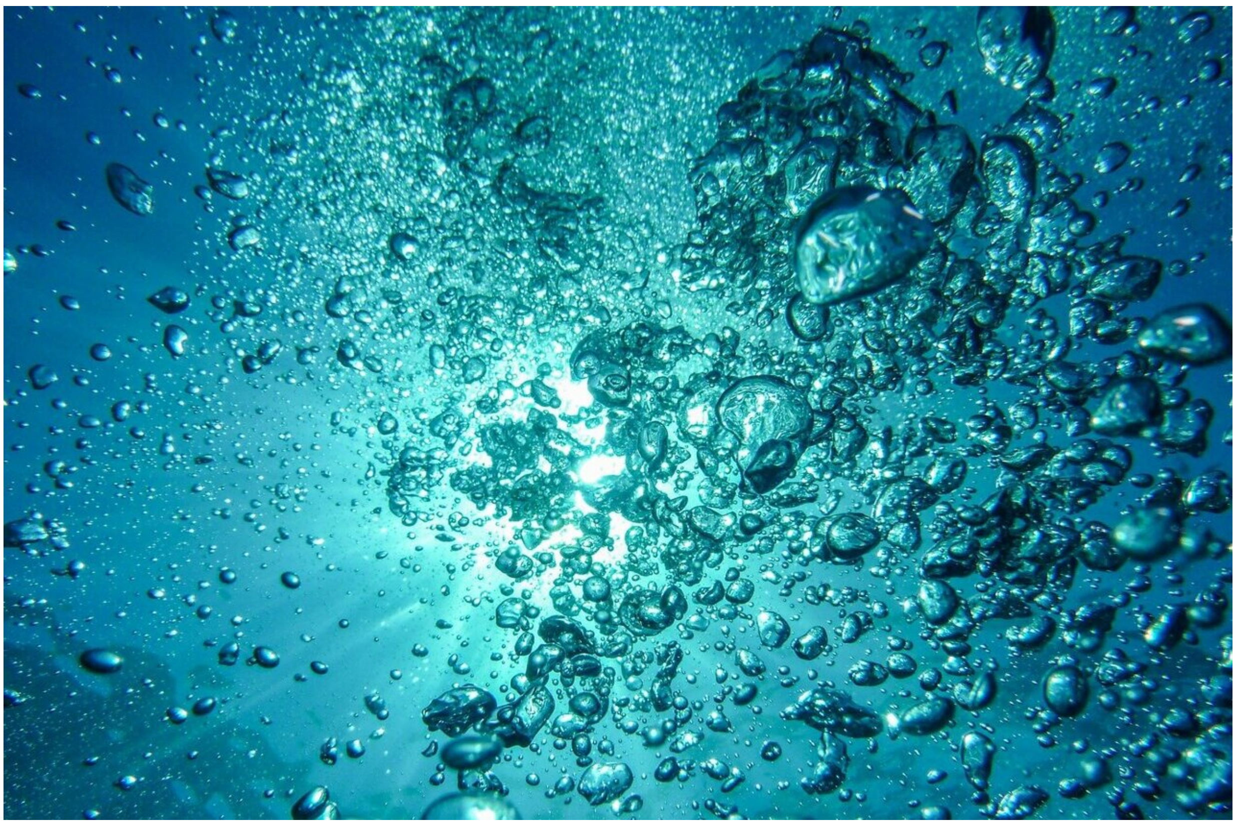

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While structures which emulate foam-like arrangements of bubbles are lightweight and cheap to build, they are also remarkably stable. The bubbles which cover the iconic Beijing Aquatics Centre, for example, each have the same volume, but are arranged in a way which minimises the total area of the structure—optimising the building's construction. The mathematics underlying this behaviour is now well understood, but if the areas of the bubbles are not equal, the situation becomes more complicated. Ultimately, this makes it harder to make general statements about how the total surface area or, in 2-D, edge length, or 'perimeter', can be minimised to optimise structural stability.

In new research published in *The European Physical Journal E*, Francis Headley and Simon Cox at Aberystwyth University in the UK explore how different numbers of 2-D bubbles of two different areas can be arranged within circular discs, in ways which minimise their perimeters.

Using computer simulations of up to ten bubbles, the duo investigated how the shapes of the bubbles could be optimised, while obeying the mathematical laws for bubble formation. Their work could pave the way for new designs of complex foam-like structures which are both stronger and cheaper than previous designs. It could also provide new insights into the general physical laws which govern the optimal layouts of bubbles with differing areas. To arrive at these conclusions, Headley and Cox noted how complexity increases rapidly for larger numbers of total bubbles; while five bubbles can be arranged in 20 different ways, a total of 314,748 structures are possible for ten bubbles.

Headley and Cox calculated their optimal bubble arrangements using advanced software to find the lowest perimeter arrangement of bubbles for each area ratio. For each quantity of bubbles, they ultimately determined that the number of structures with the smallest perimeter for some range of area ratios increased as the number of bubbles increased, and hence that the range of area ratios which yields a particular bubble structure with the smallest perimeter became narrower.

More information: Francis Headley et al, Least perimeter partition of

the disc into N bubbles of two different areas, *The European Physical Journal E* (2019). DOI: 10.1140/epje/i2019-11857-0

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