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# High-Speed Imaging and Acoustic Measurements of Dual-frequency Ultrasonic Processing of Graphite in Water

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**Abstract :** Ultrasonic cavitation is used for various processes and applications. Recently, ultrasonic assisted liquid phase exfoliation has been implemented to produce two dimensional nanomaterials. Depending on parameters such as input transducer power and the operational frequency used to induce the cavitation, bubble dynamics can be controlled and optimised. Using ultra-high-speed imagining and acoustic pressure measurements, a dual-frequency systemand its effect on bubble dynamics was investigated. A high frequency transducer (1.174 MHz) showed that bubble fragments and satellite bubbles induced from a low frequency transducer (24 kHz) were able to extend their lifecycle. In addition, this combination of ultrasonic frequencies generated higher acoustic emissions (~24%) than the sum of the individual transducers. The dual-frequency system also produced an increase in cavitation zone size of~3 times compared to the low frequency sonotrode. Furthermore, the high frequency induced cavitation bubbleswere shown to rapidly oscillate, although remained stable and did not transiently collapse, even in the presence of a low pressure field. Finally, the spatial distribution of satellite and fragment bubbles from the sonotrode were shown to increase, extending the active cavitation zone. These observations elucidated the benefits of using a dual-frequency system for generating nanomaterials with the aid of ultrasound, in deionised water.

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