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Editorial

Advanced techniques to reveal the underlying physics of ultrasonic processing☆

We have initiated this Special Issue with the aim of collecting and compiling under one umbrella the most advanced experimental and numerical techniques used in understanding the physical phenomena across different length and time scale during ultrasonic processing, i.e. cavitation, shock waves, high-frequency oscillations, acoustic flows, and their interactions with liquid and solid phases. There are several teams in the world that are deeply involved in this type of research, and we expected to get some 20–25 papers published in this Special Issue. In our view, this type of research – namely the specialised techniques for quantifying the effects and mechanisms of ultrasonic processing – is underrepresented in the open literature. Contrary to our expectations, we have not received papers from many of the researchers that are active in this area, despite direct invitations. Apparently, the current research and financial environment does not stimulate publishing open access original or review papers even in such a highly reputed and ranked journal as Ultrasonics Sonochemistry, which is a pity. We only hope that this will change and as new techniques emerge they will be reported, aiding our deeper understanding of the underlying physics of ultrasonic processing.

Nevertheless, this Special Issue has twelve good quality papers that are published, covering a wide range of methods and applications.

Five papers describe and apply numerical methods dealing with physical phenomena occurring upon acoustic and hydrodynamic cavitation in various liquids [1–5]. Two of those [1,2] describe the propagation of ultrasonic waves in viscoelastic liquids, which has direct implications in the emerging use of ultrasonic processing upon manufacturing of composite materials. Stability of oscillating cavitation bubbles is discussed in ref. [3]. A CFD analysis was applied to optimise the energy efficiency of a hydrodynamic cavitation reactor [4], and a comprehensive mathematical and numerical modelling framework for simulations of the complex physics and highly dynamic phenomena that occur across different length and time scales in the processes of sonochemistry and sonication of materials is presented in ref. [5]. In the latter paper, the model was also validated using advanced in-situ synchrotron observations. These papers [1–5] demonstrate that with the advance of high-performance computers, numerical modelling is becoming an indispensable tool for fundamental studies and optimization of ultrasound-assisted processing of materials.

Advanced characterisation of ultrasonic processing using in-situ techniques is the focus of six papers [5–10]. Two of those are dedicated to high-resolution, high-speed synchrotron X-ray imaging [5,6] while the others used high-speed optical imaging of transparent systems [7–10]. Potential applications of these insightful observations range from sonochemistry to exfoliation of 2D materials, and from grain refinement to the manufacturing of composites. Paper [10] gives a comprehensive review of shock waves that are responsible for many physical phenomena occurring upon ultrasonic processing.

Two final papers are dedicated to very different applications of ultrasonic processing. Paper [11] suggests an interesting hypothesis that pre-cavitation ultrasound may affect nucleation in metallic alloys, while paper [12] discusses the effect of ultrasonic intensity on the cooking time of starch.

Overall, this Special Issue illustrates the breadth and importance of experimental and numerical techniques for revealing the physical mechanisms of ultrasonic processes for a wide range of applications. We hope that readers will find these papers stimulating and valuable as references, but also as a guide and inducement for future research.

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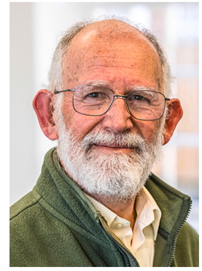

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