P-10: Influence of Nanoparticles Introduction in a Liquid on Sonoluminescence and Cavitation Noise Spectra

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Applications of high intensity focused ultrasound (HIFU) in experimental and clinical therapies has received last years increased attention. It is believed that cavitation plays an important role in bioeffects, and some effects are caused by bubbles pulsations and implosions as discussed by Mason, (2011) and Miller (2009). From other side magnetic nanoparticles can be used for targeting drug delivery and drug release can be enhanced by ultrasound (Saravanan, 2004).

The possibility for controlling the cavitation activity by magnetit nanoparticles introduction in a liquid in HIFU conditions has been studied in the present work. Agglomerates of magnetit nanoparticles were used in experiments. Cavitation activity was estimated in two ways: by sonoluminescence (SL) intensity and by the integral intensity of the wide-band patterns of the cavitation noise spectra. The Cavitometer ICA-4HF (made in BSUIR) was used for integral noise measurements. Experiment were done at 720 kHz and 1450 kHz.

It has been shown that both cavitation activity and the dynamics of the cavitation zone development are strongly influenced by nanoparticles introduction into the liquids. Both the first and the second thresholds were decreased, cavitation activity was increased at concentration up to 0.8 mg/mL, than it was decreased with particles concentration for all ultrasound intensities studied. Sonoluminescence intensity was decreased with particles concentration increase for high ultrasound intensities as well as the cavitation activity measured by ICA-4HF. Spectral characteristics of the acoustic emission from cavitation zone also were changed significantly with particles concentration increase. It was clearly seen from the results obtained that the introduction of nanoparticles decreases significantly time delay between the beginning of sonification and the sonoluminescence appearance. This means that the introduction of particles in a liquid increases cavitation nuclei concentration and changes nuclei size distribution. Every particle may serve as nuclei by itself. Air adsorbed on particles surface and air bubbles inside agglomerates of particles is another source of nuclei. As a result also bubbles density in cavitation zone is increased. This was confirmed by the increase of ultrasound energy absorption.

The diminishing of cavitation activity with particles introduction at high ultrasound intensities may be caused by increased concentration of big bubbles, bubbles interactions, clustering and screening action of the cavitation field as it was discussed in literature, for example by Hallez et al.(2010). Bubbles interactions by shock waves and Bjerkness forces may lead to deviations from the spherical bubble shape at early stage of collapse and decrease the efficacy of energy transformation and concentration in a cavitation zone.

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