Characterization of Sono-sensitive Nanocarriers for Oxygen Delivery

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Acoustic cavitation is the physical phenomenon that leads to the formation, growth and collapse of bubbles due to the acoustic pressure variation induced by Ultrasound (US) in a liquid [1]. Over last 15 years, this phenomenon has been investigated in the nanomedicine field, with a particular attention to the development of different drug loaded nanocarriers which can be activated by US in order to release their content, or activate radicals formation process as a consequence of cavitation.

In this study the acoustical and optical response of two different sono-sensitive nanocarrier systems have been investigated.

The first type of nanocarriers are commercial ZnO nanoparticles (ZnO-NPs), that behave as cavitation nuclei, increasing the cavitation activity because of the presence of trapped gas pocket on their surface [2]. The seconds are perfluorocarbon based oxygen-loaded nanodroplets (OLNDs) with differing coating: polyvinyl-alcohol (PVA-OLNDs) or chitosan (Chito-OLNDs). In this case, bubbles formation arises from the acoustic droplet vaporization process induced by US and then bubbles start oscillating up to collapse [3].

In this context, in order to obtain a metrological characterization of cavitation, a passive cavitation detector (PCD), an ecographic probe and a high-speed camera were used. The solution with the nanocarriers was led to flow into a silicone-based customized phantom and both quantitative and qualitative real-time analysis of the US response were performed.

Results show that the cavitation activity observed by means of the PCD sensor (Fig. 1a) can be correlated to the amount of bright light spots detected by the ecographic probe (Figs. 1b, 1c). Furthermore, the analysis carried out through the high-speed camera (Fig. 1e) allows to understand the dynamics of the three samples. From these results, the mean time detected to observe the cavitation event (Fig. 1d) can be evaluated, confirming the dependency on the nanocarrier structure previously observed with the PCD analysis.

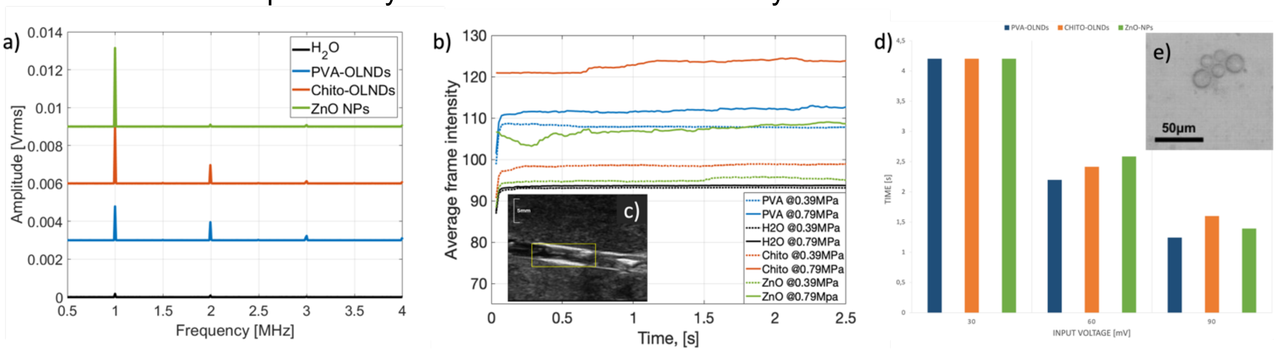

Fig. 1 (**a**) Cavitation spectra of NPs and OLNDs from PCD analysis; (**b**) Average intensities of the light spots detected by the ecographic probe at different acoustic pressures for each sample; (**c**) Frame recorded with the ecographic probe; (**d**) Average time duration of the cavitation event at different acoustic pressures; (**e**) Frame recorded by the high-speed camera during bubbles oscillation.

References

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