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High power sources for ultrasound thermal therapy and shock wave lithotripsy

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We present a summary of Inserm's experience with high power sources, which are necessary for ultrasound thermal therapy and lithotripsy. Moreover, generating high intensity pseudo-continuous waveforms or high pressure pulses imposes different constraints on the transducer materials, specifically heat and mechanical stress. For thermal therapy, miniature piezoceramic transducers were used for interstitial, intratumoral, and endoluminal applicators. These probes operated at surface intensities up to 50 W/cm^2 and generated elementary lesions in vivo within tens of seconds. Piezocomposite transducers were developed for large-aperture, highly-focused beams used in extracorporeal or intraoperative treatments. Focal intensities were 1000 W/cm^2 or higher and up to 256 elements were utilized. Miniaturized piezocomposite transducers are currently being developed for dual-mode imaging and therapy. For lithotripsy, piezoelectric shock wave generators were developed as alternatives to electrohydraulic or electromagnetic generators. Using piezocomposite materials and a novel pre-straining method increased transducer surface pressure compared to a multi-element piezoceramic design, and therefore halved the aperture diameter. In in vitro tests, plaster kidney stone models were comminuted with ∼200 shock waves, a number comparable to values published for electrohydraulic generators, the current 'gold' standard. This work contributes to the advancement of transducer performance in therapeutic ultrasound. [Supported by Inserm Post-doctoral Fellowship]