

High Intensity Focused Ultrasound (HIFU) Lesion Formation Monitoring Using Acousto-Optic Imaging

Puxiang Lai, James R. McLaughlan, Andrew B. Draudt, Todd W. Murray, Robin O. Cleveland, and Ronald A. Roy

Boston University, Dept. of Mechanical Engineering,

110 Cummington Street, Boston, MA 02215

Tissue heating by HIFU is a promising modality for minimally-invasive therapy. However, real-time treatment monitoring still poses significant challenges, particularly at the lower exposure levels where stable cavitation and/or boiling does not result. Bubble free HIFU “lesions” offer little acoustic contrast, however, one does observe significant contrast in both optical scattering and absorption. We employ acousto-optic (AO) imaging to sense, in real time, optical changes induced by lesion formation. By using a transducer to simultaneously heat a tissue volume and pump the AO interaction, lesions generated in excised chicken breast are monitored in real time. The change in AO response with time is linearly related to the time-dependent lesion volume, provided the diameter of the lesion does not exceed the width of the acoustic beam. Therefore, AO sensing can be used to both determine the onset of lesion formation and the resulting volume of the necrosed region. The feasibility of using the observed change AO signal amplitude as the criteria to guide HIFU exposure in real time is demonstrated. (Work supported by the Center for Subsurface Sensing and Imaging Systems, NSF ERC Award No. EEC-9986821)