Microwave-Induced Thermoacoustic Tomography Experimental Study and FDTD Modeling

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Microwave imaging is an imaging technique that gives high dielectric material contrast but poor spatial resolution due to the relatively long wavelength (centimeters) of electromagnetic waves in this band at far-field. Conversely, ultrasonography provides a high spatial resolution using a diagnostic frequency of up to 20 MHz. The acoustic wavelengths are in the millimeter range but yields poor contrast between soft tissues and materials of similar density. Combining these two techniques one is able to create an imaging technique with high contrast and high resolution, in a method known as Microwave-Induced Thermoacoustic Tomography (MI-TAT). This noninvasive hybrid modality, improves contrast by using thermoelastic wave generation induced by microwave absorption. Samples are illuminated with sub-microsecond microwave pulses inducing the acoustic wave in the sample that are then received with an unfocused transducer. The advantage of this technique lies in combining the high contrast of microwave absorption coefficients for different biological tissues and the superior spatial resolution of ultrasonic waves. Such technology is important in providing a low-cost alternative to magnetic resonance imaging (MRI) or for Nondestructive Testing (NDT).

We report the results of an improved experimental setup using a 2 kW peak power microwave source with 1 microsecond pulses. Acoustic signals are observed using an ultrasound PCI card and an Olympus 5800PR pulser receiver system. Shielding has been improved to minimize radiation leakage into the environment and to the transducer. An updated FDTD model that accurately represents the experimental setup is also developed. Samples tested in the experimental setup include simulated tissue phantoms to concrete samples. The tissue samples are used to determine the effectiveness for medical imaging applications and the concrete is to test the non-destructive testing (NDT) applications.