Reflection Of Microwave Pulses From Acoustic Waves: Summary of Experimental and Computational Studies

G.M. Kepler, R.A. Albanese, H.T. Banks, and V.A. Bokil

This report represents a summary of our experimental investigations to detect the scattering of microwave frequency electromagnetic waves by induced acoustic structures. The essence of this experiment consists of launching electromagnetic and acoustic waves that will be coincident in a target and using time domain reflectometry (TDR) measurements to detect reflections of the electromagnetic wave off the acoustic wave front.

To date, we have constructed a workable experimental antenna where we can launch EM waves at an agar target and make TDR measurements. The circuitry and timing necessary to initiate an acoustic wave and synchronize it with the EM pulse have been built. We have carried out TDR experiments with different delay times, pulse widths, and target thicknesses.

In our experiments we found no evidence of EM reflection from the acoustic wave front for the range of inputs in which our experimental antenna can be operated. Experimental results are complicated due to jitter in the time base which results in slight offsets and spikes in the subtracted signals. These spikes in the subtracted signal are also observed when the input pulse reflects from the feed of the antenna, further obscuring results in the vicinity of interest. In addition, the long-term oscillations that have been observed in the subtracted data seem not to be the result of acoustic events, but an artifact of the transducer/timer circuitry interacting with the electromagnetic signal in the case when the transducer circuit is connected to the timing circuit.

Evaluation of the expected pressure dependence of the agar indicates that it would be difficult to observe EM reflection from the acoustic wave front with our current transducer, where the magnitude of the pressure wave is estimated to be on the order of 0.1 Pa. range. A suitable source for acoustic waves must satisfy a difficult set of constraints. It must be much more powerful than our current transducer, must be remotely controlled for synchronization of the EM and acoustic signals, must produce a high frequency pulse that produces a sharp wave front in the material, and, ideally, would not interact with the EM field in the antenna (no wires or metal parts).