ACOUSTICS2008/63
Experimental confirmation of negative dispersion and Bayesian inversion of multimode propagation in a bone-mimicking phantom

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Previously we demonstrated using numerical simulations that negative dispersion observed in bone can result from the interference of two propagating modes, each of which exhibits positive dispersion, consistent with the Kramers-Kronig predictions. [J. Acoust. Soc. Am. 120, EL55-61 (2006)] One goal of the present study was to demonstrate this negative dispersion experimentally using the simplest example of a bone-mimicking phantom that is capable of producing two such interfering modes. An additional goal was to establish that, with the experimental data serving as input to a Bayesian approach to the inverse problem [J. Acoust. Soc. Am. 121, EL8-15 (2007)], reliable estimates of the underlying properties of the bone-mimicking phantom could be obtained from the measured signals. The phantom consisted of a flat and parallel PlexiglasTM plate into which a step discontinuity was milled. The phase velocity and attenuation coefficient (3 to 7 MHz) of the phantom were measured with a 0.25-inch piezoelectric receiver and calculated using both broadband and narrowband data. Negative dispersion was observed at specific spatial locations near the step where the attenuation coefficient rose approximately linearly with frequency. Results demonstrate that interference between modes can result in negative dispersion and that Bayesian inversion can yield underlying material properties.