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Second order dispersive effect on zero-group velocity Lamb modes

Daniel Royer, Dominique Clorennec and Claire Prada
Laboratoire Ondes et Acoustique, ESPCI, Université Paris 7, CNRS, 10 rue Vauquelin, 75005 Paris, France

After a local and transient loading of a plate, the acoustic energy decay in the source area can be explained by three mechanisms: the energy transport phenomenon at the Lamb wave group velocity, the material damping and the second order dispersive effect. Generally, the first mechanism dominates the other two. However, some dispersion curves of Lamb modes present a minimum frequency for a nonzero wave number. Since at these points the group velocity vanishes, no energy transport occurs, and the slower other two phenomena can be observed. Using laser-based ultrasonic techniques, we show that the mechanical response of various thin metallic plates to a laser pulse impact is dominated by the resonance of the zero group velocity S_1-Lamb mode. In the first microseconds, we observed a $t^{-1/2}$ decay of the local vibration amplitude, which cannot be explained by the material damping. We demonstrated that this effect is ascribed to the second order term in the dispersion relation. After this power law decay, the mechanical displacement undergoes an exponential decay corresponding to the wave damping. Then, we show that the local attenuation of the plate material can be measured without any mechanical contact.