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Computational time reversal acoustics imaging of embedded defects in solid media

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Time Reversal Acoustics (TRA) techniques can exploit the nonlinear processes emerging from the interaction between the incident waves and nonlinear scatterers in solid media in order to localize and characterize the scatterers themselves. When nonlinear scatterers are embedded, their localization can be obtained through a mixed experimental/numerical TRA procedure: the forward propagation is performed experimentally, while the Time Reversal (TR) backward propagation is simulated using computational codes and a reference model of the solid. The synergetic use of dedicated processing of the forward propagation signals collected at the Time Reversal Mirror (TRM), for example with Nonlinear Elastic Wave Spectroscopy (NEWS) techniques, and the calculation of the backpropagated wave fields at each point within the specimen leads to imaging of the nonlinear scatterers. We show examples of nonlinear scatterer (macroscopic cracks, distributed microcracks) imaging by such a procedure, exploiting high performance (parallel) computational codes. We address issues in the imaging method related to the discrepancy between the reference model of the specimen and the real specimen itself. Finally, we address the implementation of the technique for Non-Destructive Evaluation (NDE) real-world applications using multi-threaded computational codes to be run on common multi-core desktop computers.