# Proof of Concept of Second Harmonics Suppression Using Waveguide Metamaterial Rod

**SANDEEP KUMAR S R[1], KRISHANDAS VK[2], KRISHNAN BALSUBRAMANIAM[1], PRABHU RAJAGOPAL[3]**

[1]Center for Non-Destructive Evaluation, INDIAN INSTITUTE OF TECHNOLOGY MADRAS, India, [1] Mechanical Engineering Department, INDIAN INSTITUTE OF TECHNOLOGY MADRAS, India, [1] Mehcanical Engineering, INDIAN INSTITUTE OF TECHNOLOGY MADRAS, India

Nonlinear Ultrasonics (NLU) is widely used to detect micro-cracks and microstructural changes in materials due to its high sensitivity. NLU makes use of higher harmonics caused by various nonlinearities like equipment, micro-cracks, defects, voids, surface cracks, grain boundaries for material characterization. However, there can be instrument-related nonlinearities arising from high power amplifiers, transducers, couplants, etc which are adding up with material related nonlinearities, leading to inaccurate measurements. The measurement of these nonlinearities is crucial and is quantified by nonlinearity parameter(β), which is the ratio of fundamental and second harmonic. In this paper, we are presenting a bandgap based metamaterial to improve the accuracy and identifiability of the higher harmonic features by removing the inherent nonlinear due to the instrumentation. The dispersion relation and bandgap in the metamaterial rod were studied on an optimally designed unit cell with Bloch-Floquet condition. We demonstrate proof of the concept of higher harmonic suppression by selectively suppressing the second harmonic due to the instrumentation on a waveguide metamaterial rod. Finite Element simulations were done to demonstrate this concept. This approach of using metamaterial rod in NLU shows great potential for Structural Health Monitoring (SHM) and Non-Destructive Evaluation (NDE) applications with its wave manipulation capability and more accurate predictions.