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Finite element simulation of sonotrode for ultrasonic additive manufacturing on dynamic performance

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Ultrasonic additive manufacturing, also called ultrasonic consolidation is an approach to realize bonding between metal foils without phase change, which lead to faster and more accurate 3D formation of mechanical parts. As a key energy transformation component in ultrasonic consolidation system, the sonotrode conducts vibration excited by piezoelectric transducers and transfers mechanical vibration into bonding energy between metal foils. This work presents the operation principle of sonotrode and introduces a way to build its finite element model. This model is automatically built by APDL (ANSYS Parametric Design Language) programming language of commercial finite element software ANSYS. The influence of geometric parameters on dynamic performances is investigated by the way of sensitive analysis. Modal and harmonic analysis are conducted to obtain harmonic response under different combination of voltage excitation. In order to find an optimized way of electrical excitation and acceptable geometric parameters set of sonotrode, the ratio of mean vibration amplitude in contact zone to electrical power applied to piezoelectric transducers is defined to describe the efficiency of energy transformation. With the help of optimization module of ANSYS, a way of designing geometric parameters of sonotrode is presented and the relation between phase difference of two exciting voltage input and the ratio defined above is curved. A prototype of sonotrode is fabricated according to simulation results. Harmonic response of the prototype verifies the validation of finite element model.

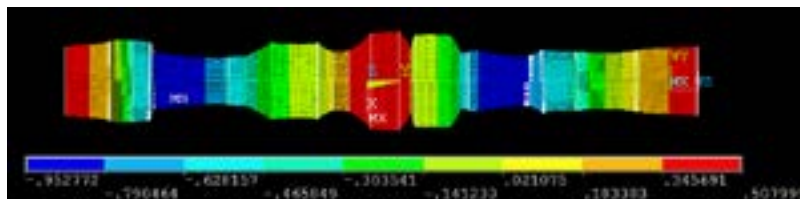


Figure 1: Modal shape of sonotrode.

Biography

Changcai Cui has completed her PhD from Harbin Institute of Technology, China. She is the Head of the Department of Precision Measurement Technology and Instrumentation of Huaqiao University, China. She has published more than 70 papers in journals and conferences and has been a corresponding Reviewer of some journals. She is interested in researching performance verification and measurement technology in manufacturing.

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