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Modeling of Ultrasonic Microwelding System by Finite Element Method

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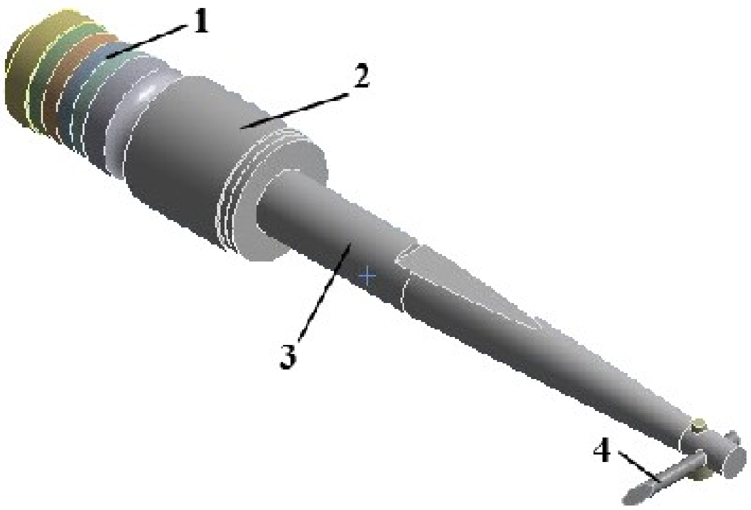
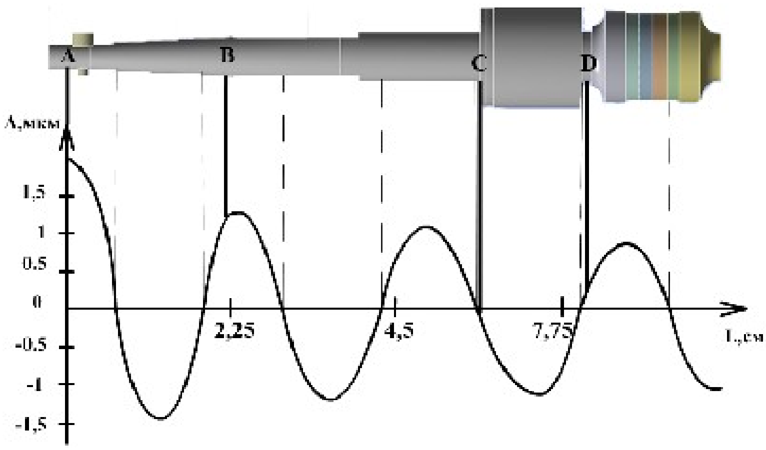
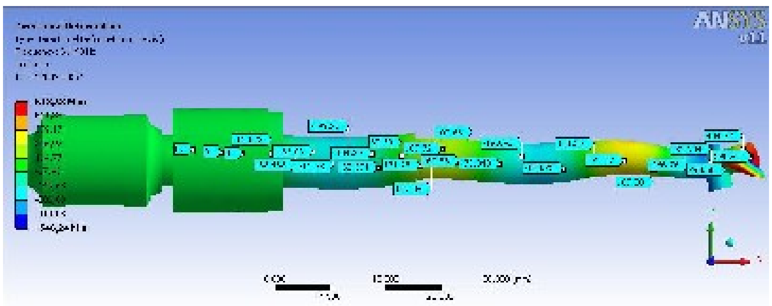
While assembling electronic products, ultrasonic microwelding (US) is widely used to generate the electrical connection between contact pads of a die and package leads of the technology "smart-card". This type of welding is highly automate and universal to different geometrical sizes of packages. The advance direction of US microwelding development is an increase of fluctuation frequencies from 66 up to 140 kHz. This enables you to reduce the amount of amplitude fluctuations without changing the acoustic power, reduce the sign-variable voltage in welded materials and the risk of fatigue destruction of microconductors.
A complex finite element method (FEM) analysis ANSYS was selected as a tool for modeling. The model was built, values and forms of fluctuations of US microwelding technological system were defined based on FEM. Approximation is based on a choice of basic functions and the subsequent search of the factors ak.
US microwelding system includes the generator and US converter, which transform electric energy in energy of mechanical fluctuations. The design of US converter will consist of the following parts (Fig. 1): the piezoelectric vibrator, the cylindrical holder, the wave guide and the tool which is secured using a retainer clip. The choice of resonance frequency depends on the size of the welding system and the opportunities for its modernization.
During the work of US microwelding technological system, the occurrence of lateral frequencies, harmonics and subharmonics of resonant frequency takes place.
The resonant frequency of a standard US system of microwelding is 66,2 kHz with the increased frequency of fluctuations system - 92,8 kHz. The distribution of the wave form for these frequencies is shown on Fig. 2 and Fig. 3. The axial distribution of a wave was observed on other frequencies, which is not acceptable for US welding. The amplitude of fluctuations grows along the system of microwelding due to amplifying properties of the concentrator and the harmonization of the elements of the entire system.
The dynamic characteristics of US systems were tested on scanning laser system PSV-400 Polytec. The distribution of amplitude fluctuations along the US system revealed that the amplitude on the tool is 1,0â€“1,5 microns (Fig. 4). The microwelded connections had the strength of the 11-14 g for wire diameter 30 microns with initial breakage effort 20â€“21 g and approximate lengthening of ~1 %.
In conclusion, modelling of own frequencies and intensifying properties of US microwelding systems has allowed to provide the coordination of different elements of the system and to achieve high durability of microwelded connections. The increase of fluctuation frequency provides the formation of connections in a short time and at low temperature heating.

References
[1]. Design of a Smart Ultrasonic Transducer for Interconnecting Machine Applications / Tian-Hong Yan and est. // Sensors, 2009, № 9. â€“ P. 4986 â€“5000.

Pictures:







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