ULTRASONIC TECHNOLOGIES.
PHYSICAL EFFECTS AND MODERN INDUSTRIAL APPLICATIONS

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INTRODUCTION

The use of the energy of ultrasonic vibrations in technological processes has found wide industrial application, covering almost all industries, from electronics, instrumentation and ending with mechanical engineering. Powerful ultrasonic vibrations in liquid media cause a number of physical effects in them, which are widely used in various fields of technology. Most of the physical processes occurring in powerful ultrasonic fields are non-linear. The parameters that characterize them are important for optimizing technological processes using ultrasound (US). The use of ultrasonic technologies makes it possible to carry out a technological effect on the surface layers of materials, which ensures the formation of the required properties and the possibility of creating contact joints in the solid phase. The main advantages of using ultrasonic treatment are the ability to influence the surfaces of materials at the macro-, micro- and sub-micro level, the absence of the need to use expensive and environmentally harmful reagents and consumables, and the wide possibilities of process automation [1].

At present, a promising direction in the development of production technologies is the use of carbon nanomaterials, in particular carbon nanotubes. The use of carbon nanotubes can significantly improve the mechanical and electrical properties of products made from these materials. The widespread use of highly efficient, environmentally friendly ultrasonic technologies currently provides an increase in the reliability and durability of electronics products, instrumentation and mechanical engineering.

In the 21st century, it is difficult to find an area of human activity in which electronic means (ES) would not be an important assistant to a person. Electronic means are extremely diverse both in terms of functionality and their design, which allows them to be used to control systems of personal computers, spacecraft, aircraft, cars, televisions, mobile phones, digital cameras, DVD players, etc. In the modern world, there is the rapid development of ES in response to the growing needs of telecommunication technologies, aerospace technology and instrumentation.

The transition to lead-free solders when mounting electronic modules poses a number of tasks to ensure good wetting of surfaces, optimize heating temperature profiles, and control the quality of joints. With an increase in the functional complexity of the EC, the problems of mounting and dismounting electronic components from the surface of the boards grow, especially multi-lead BGA packages that are contacted using ball leads [2].

An increase in labor productivity, quality and reliability of contact connections in electronic modules can be achieved through the widespread use of automated equipment with microprocessor control, concentrated ultrasonic energy flows, electromagnetic fields, including high-frequency, infrared, laser radiation, in the processes of soldering, microwelding and cleaning during formation connections.

Chapter 1 discusses the physical effects of ultrasonic vibrations on liquid and solid media and possible areas of application of ultrasonic technologies in modern industry. The classification of primary and secondary ultrasonic effects and their application in technological processes of contamination removal, dispersion, soldering of hard-to-solder metals and alloys, metallization of non-metallic materials, macro- and microwelding in electronics are given.

Chapter 2 is devoted to activation of cavitation processes in liquid media, forced by the introduction of gaseous cavitation nuclei and the passage of electric current, which creates conditions for intensification of diffusion, dissolution and emulsification processes in the treatment zone, accelerates the processes of ultrasonic cleaning of surfaces in liquid media and increases the strength of solder joints. Devices for monitoring cavitation pressure in liquid media are considered, which makes it possible to optimize the parameters of ultrasonic exposure.

Chapter 3 presents the results of studies of ultrasonic cleaning processes, which exclude the use of flammable and toxic organic solvents and allow the use of only aqueous solutions of technical detergents. This improves working conditions, raises the culture of production, and also solves environmental safety issues. Recommendations on the choice of ultrasonic process equipment are given.

Chapter 4 discusses processes and equipment for ultrasonic dispersion of nanoparticles and solder powder in liquid media, as well as ultrasonic impregnation of winding products and porous materials.

Chapters 5 and 6 are devoted to the processes of ultrasonic soldering of hard-to-solder metals and alloys and ultrasonic metallization of non-metallic materials in the production of electronic components, devices and solar panels. These processes make it possible to abandon the use of fluxes, as well as save precious metals such as gold, platinum, silver in production.

Chapters 7 and 8 discuss processes and equipment for macro- and micro-welding in the production of electronic products, and give recommendations for achieving high quality products. Ultrasonic structural welding is promising for joining dissimilar and different thickness metals and plastics without removing oxide films. Ultrasonic wire microassembly is widely used for assembly of microelectronic products due high automation of processes and versatility to various technological options for production.

Ultrasonic Technologies

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