GENERATING ACOUSTIC VIBRATIONS IN THE AIR MEDIUM BY USING A GAS DISCHARGE EMITTER

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By using an atmospheric-pressure spark discharge, an apparatus and methodology for generating acoustic waves in the air medium were developed [1]. The gas discharge operation principle involves the forming of electric current pulses (t_p <1 μs) in the electrode system of the emitter while the storage capacitor discharges through the gas discharge plasma channel. This leads to the appearance wide range of acoustic vibrations, in the ambient air and, correspondingly, on the emitter surface. By using the scanning laser Doppler vibrometry technique [2-4] in the time mode, the damped vibrations of the emitter membrane were measured during discharge current flowing. A typical graph of vibrations magnitude in the center of the membrane is shown in fig. 1.

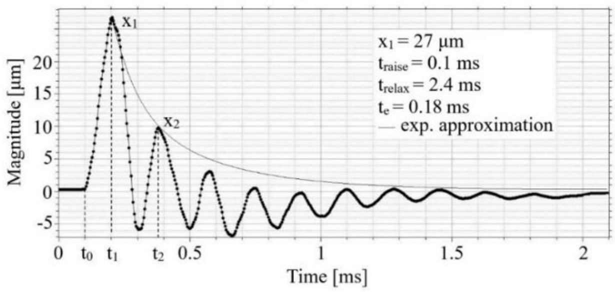

Fig.1. Vibrations of gas discharge emitter membrane excited by gas discharge electric pulse.

The evaluation of membrane vibrations showed that the amplitude of the first maximum of 1-mm aluminum membrane oscillations reached 27 μm in the case of a minimal inter-electrode gap of 5 mm. Typical relaxation time is 2.1 ms, therefore, in the particular experiment, the recording time at each scanned point was chosen to be under 4 ms. This allowed recording emitter vibrations with the pulse repetition rate up to 30 Hz. In general, the results above show that the grade of damping of the oscillating system was low and it can be corrected by changing damping characteristics in particular applications.

The amplitude-frequency spectrum of the proposed gas discharge emitter, as well as repeatability of the amplitude of vibrational displacement in the pulsed mode were analyzed. As a result, a non-stable character of vibrational displacement on the emitter membrane was demonstrated. The periodicity of measured is probably related to the physical processes in the gas discharge caused by variations of gap and plasma parameters.

The mean displacement value matches well the corresponding characteristic of classical piezoelectric and magnetostrictive transducers [5]. Moreover, the amplitude-frequency spectrum analysis shows that the emitter generates acoustic waves in the air in the total frequency range from 50 Hz to 100 kHz and can be used for non-destructive testing of composite materials. An example of using a gas discharge emitter in combination with SLDV for nondestructive testing of a hybrid flax/carbon fiber reinforced composite is presented to confirm the possibility of defect evaluation.

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