PECULIARITIES IN MEASUREMENT OF PRESSURE PULSES WITH A DIELECTRIC SENSOR

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The dielectric pressure sensor developed at the Institute of Strength Problems of the Academy of Sciences of the Ukrainian SSR [1] is widely used for study of shock-wave processes in condensed media [2-4]. As follows from [1], the principle on which the sensor operates is the generation of varying electrical charges by an electrically polarized dielectric disk upon shock compression. It was shown in [2] that the effect of shock polarization on the signal is produced by a change in capacitance due to compression of the dielectric under load, which then determines the value of the pressure acting.

In the present study we will consider the possibility of measuring multiwave shock wave profiles with dielectric sensors. The sensor is a planar capacitor, the electrodes of which are formed by 0.02-mm-thick copper foil. The working area of the electrodes is 8×8 mm, with 60-70-mm-long leads, 0.5-0.8 mm wide. The sensitive element is formed by a Lavsan film 0.04 mm thick, a 0.11-mm-thick Teflon film, or a mica layer 0.04-0.06 mm thick. To provide electrical insulation the outer surfaces of the electrodes are covered with LT-40-38 adhesive Lavsan tape. The mechanical arrangement for the measurements was the same as that of [5]. The signal from the sensor was fed to the input of a cathode follower through a piece of coaxial cable not more than 3 m long. From the cathode follower output (R_{out} = 100 Ω) the signal was fed through up to ~30 m of RK-100 coaxial cable to the input of an S1-24 oscilloscope (R_{in} = 100 Ω). Before the experiment the measurement channel was calibrated for voltage using a G5-15 generator. Time calibration was performed using a sine wave signal from a G4-18A generator. A UIP-2 power supply was used to power the sensor and cathode follower. Initial polarization voltage was 100 V. The multiwave shock-wave profile was created using explosive devices and screens made of layers of materials with different acoustical rigidities [6]. The shock-wave amplitude was varied over the range 10-100 kbar, with duration of the first "step" of the wave varying in the range 0.5-1.5 μsec. The sensor was installed in specimens made of Plexiglas, aluminum, and copper. In each experiment the shock-wave parameters were recorded by Manganin sensors [7, 8] and in some experiments, by capacitive velocity sensors [9]. Typical oscillograms of the pressure profiles obtained with the dielectric (a) and Manganin (b) sensors are shown in Fig. 1 (p_1 = 13 kbar, p_2 = 25 kbar, time marker, 1 μsec). Figure 2 shows the relative change in capacitance of a Lavsan dielectric sensor as a function of pressure in the first shock wave.

The experiments performed revealed that when the dielectric sensor is acted upon by two or more successive pressure changes it stably "reduces" the amplitude of the second wave several times, while faithfully reproducing the time characteristics of the shock-wave profile as obtained by other sensor types. This effect of significant reduction in the voltage from the sensor is not related to any "critical" pressure, is independent of time characteristics, and is characteristic of Lavsan, Teflon, and mica dielectrics. It can apparently be explained only by an abrupt change in the physical properties of the dielectrics used under repetitive shock compression.

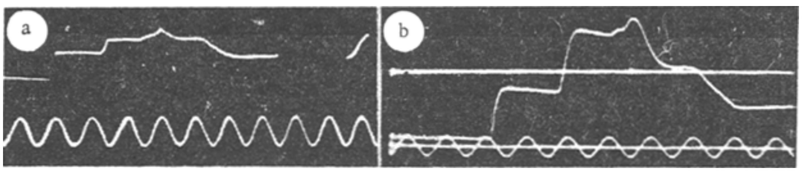

Fig. 1

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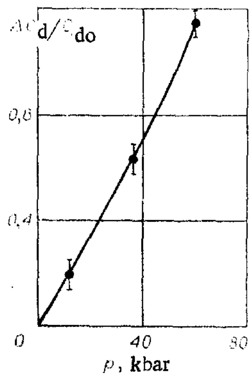

Fig. 2

Thus, it has been shown experimentally that the dielectric sensor method of recording pressure pulses does not permit registration of multiwave shock-wave configurations.

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