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SHOCK FRONT VELOCITY IN MODIFIED MAGNETICALLY DRIVEN T-TUBE

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1. INTRODUCTION

The magnetically driven shock tubes (Wright, 1961; Colb, 1957) has been widely used as a plasma source for spectroscopic investigation of atomic processes in plasma, plasma dynamics behind a shock front, plasma chemistry etc.

The parameters of the shocked gas behind the shock front (flow velocity, gas pressure and temperature) strongly depends on shock front velocity thus, changing the front velocity one can change parameters of the plasma produced in a T-tube. Because the shock velocity depends only on the voltage across the discharge electrodes and ambient pressure of the gas it is possible to produce the moving plasma with requested parameters by change those two parameters.

It is clear that the velocity of the shock front appears as a magnitude of primary importance in shock tubes.

2. EXPERIMENT

The plasma source used in this experiment is a small magnetically driven T-tube made of glass with an inner diameter of 27 mm. The end of the tube 160 mm from the discharge electrodes is connected with glass balloon 160 mm in diameter. The sock front produced in a tube expands through the balloon heating the gas.

The T-tube energized from a low inductance 4 μF capacitor bank which was charged between 9 kV and 18 kV. The discharge current is critically dumped and initiated by a 10 kV trigger pulse via spark gap. The filling gas was a pure hydrogen under a pressure between 100 Pa and 500 Pa.

The method of velocity measurement is modified and improved method used earlier (Djurović, 1980; Djurović, 1997). The apparatus set-up is shown in Fig. 1. The image of the central part of the T-tube along the tube axis is focused (1:1 magnification) on a plane, where is placed precise positioner P. The two narrow tubules are placed on the positioner on the mutual distance of $\Delta x = 15$ mm and coupled on pfhotomultiplier via optical fibers.

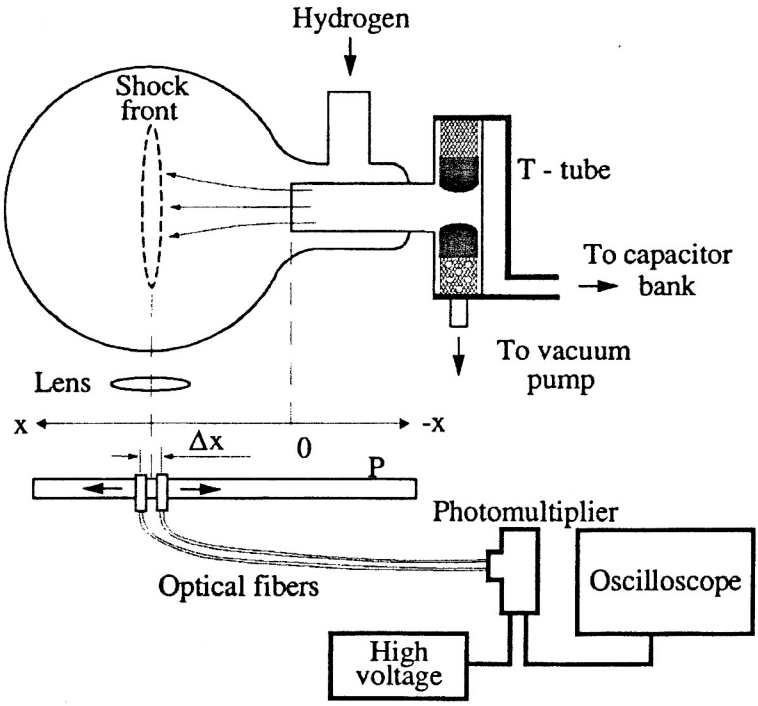

Fig. 1 Apparatus set-up

By changing position of the lens it is possible to focus any position along the line parallel to the tube axis.

3. RESULTS AND DISCUSSION

The passage of the luminous front image of a shock wave across the front ends of the tubules changes the photomultiplier signal. The signal from photomultiplier was led to the digitized oscilloscope and its typical form is shown in Fig. 2.

The time interval $\Delta t = t_2 - t_1$ between two maxima t_1 and t_2 is the time during which the incident shock front pass the distance Δx between the tubules. In this way the shock front velocity on the observed point along the tube axis can be obtained as $v = \Delta x/\Delta t$.

The time interval Δt was measured at different positions along the tube axis (with 5 mm steps) starting from x = - 20 mm (see Fig. 1).

The evaluated velocities of the shock front versus position x along the tube axis for three different filling pressures of hydrogen are presented in Fig. 3.

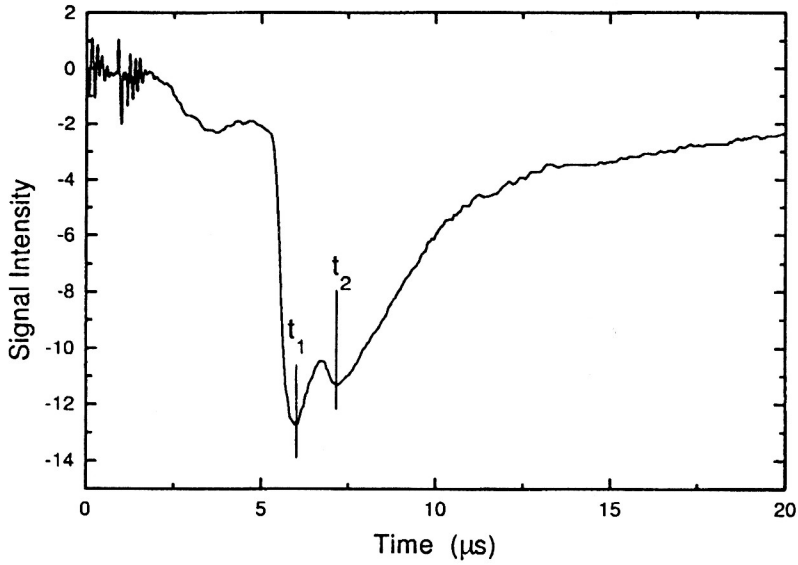

Fig. 2 Signal from oscilloscope

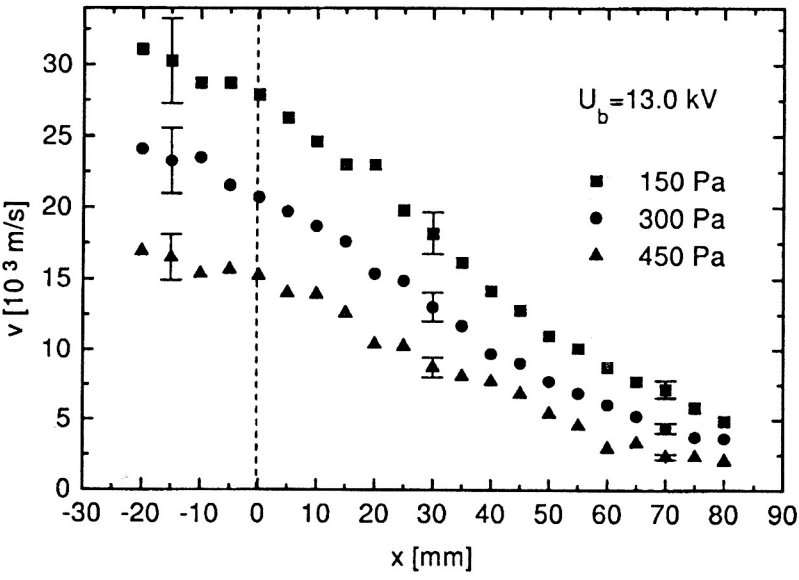

Fig. 3 Shock front velocity along tube axis for different gas pressures

The shock front velocity for the given gas pressure and position depends on the voltage across discharge electrodes. This dependence is presented in Fig. 4.

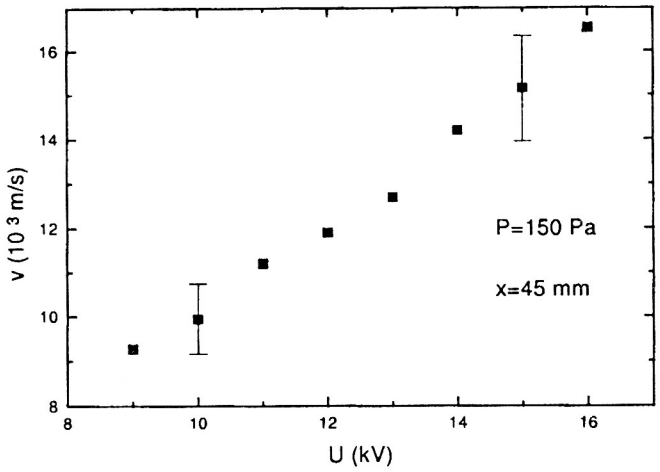

Fig. 4 Shock front velocity vs voltage across discharge electrodes

The error bars in Figs. 3 and 4 represent evaluated uncertainties in velocity determination which lies between 6% and 10%.

This preliminary measurements show that shock front velocity in the modified T-tube can change by varying the gas pressure and voltage between the electrodes. For the pressures P > 500 Pa in the case of the hydrogen measured velocities become unreliable especially for long distances from zero point (Fig. 1).

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