JETP LETTERS VOL 3, NO 2 15 JANUARY 1966

ISOTROPIC SPARK CHAMBER

G. A. Vorob'ev and N. S. Rudenko
S. M. Kirov Polytechnic Institute, Tomsk
Submitted 15 October 1965
ZhETF Pis'ma 3, No. 2, 61-63, 15 January 1966

Spark chambers in which the spark follows the track of a charged particle are presently in use in nuclear physics. While offering the advantage of producing a track of sufficient intensity to be photographed, such chambers are not very isotropic. A streamer (spark tracking) chamber is somewhat more isotropic, but its track brightness is insufficient and has different values along and across the electric field. It is concluded in [1] that it is essential to increase the isotropy of spark chambers in which the spark follows the particle track. We present here the results of development of an isotropic spark chamber.

To register in spark form the track of a particle moving in an arbitrary direction in space, we propose a spark chamber with three mutually perpendicular pairs of electrode plates. A pulsed voltage of fixed duration and amplitude is applied to each pair of plates. A certain time interval is established between the instant of termination of the voltage pulse on the first pair of plates and the instant of application of the pulse to the second (with a similar time lag between the second and third pulses). In this way the electric field in the chamber reverses its direction in space three times. To explain the operating principle of the chamber, we must distinguish between three possible directions of the particle track.

First direction. The particle track is inclined 0° - 45° to the direction of the electric field of the first plate pair. In this angle range, a pulse applied to the first pair of plates produces a spark that follows the inclined particle trajectory in the manner explained by Fukui and Mijamoto [2]. The second and third pulses will exert no great influence on the already-produced high-density plasma, because of their short duration and the short time delay relative to the first pulse, so that the particle density in the plasma will not drop noticeably during the time of action of these pulses.

Second direction. The particle track is inclined 0° - 45° to the electric field of the second plate pair. Application of the first pulse produces along the particle track a column of avalanches (as in a streamer chamber). At the same time, a voltage pulse of this duration and amplitude is perfectly adequate for production of a spark if the particle track coincides with the direction of the electric field. When the second pulse is applied, a spark is produced along the particle track. In this case the conditions for spark production are better than in the first, since the interaction between neighboring avalanches is made much stronger by the larger number of charged particles in each avalanche than in the first case. The third pulse, as in the first case, has no effect on the produced plasma.

Third direction. The particle track is inclined 0° - 45° to the electric field of the third set of plates. The first voltage pulse acts as in the second case. The second pulse develops the already-produced avalanches in a direction perpendicular to the first. The third voltage pulse produces the spark along the particle track.

The experimental setup is shown in Fig. 1. A voltage pulse with rise time 2 x 10^{-9} sec, obtained with the aid of a special generator [3], is applied to each pair of electrode pairs by a separate cable.

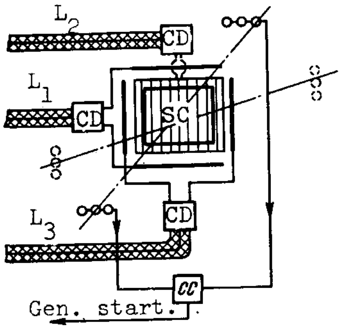

Fig. 1. High-voltage supply to spark chamber. CD - cutoff discharge gap, CC - coincidence circuit, SC - spark chamber.

The cable lengths were chosen such that the delay between pulses was 50 nsec. The duration of each pulse was regulated independently by means of three discharge gaps (nitrogen, 10 atm pressure) placed at the ends of the lines ahead of the electrode plates. The electrode plates were insulated from each other by immersion in transformer oil in a Plexiglas chamber with double walls. An external air-filled chamber contained a glass chamber filled with neon at 760 mm Hg. The dimension of the glass chamber was 10 x 10 x 10 cm. The field intensity was ~15 kV/cm. Figure 2 shows a photograph of the assembled spark chamber. Figure 3 shows a photograph of the spark produced in this chamber (the form of the spark does not depend on the particle track direction) and an oscillogram of the voltage pulse applied to the electrodes. More detailed results of tests on the chamber will be published later.

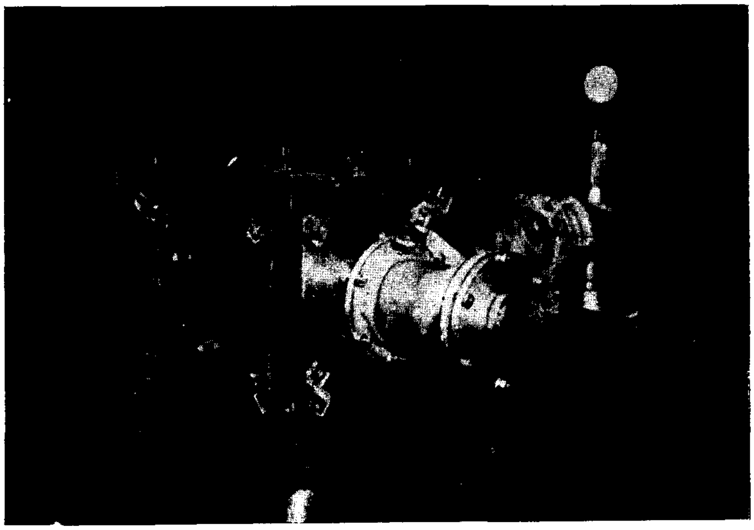

Fig. 2. Photograph of assembled chamber.

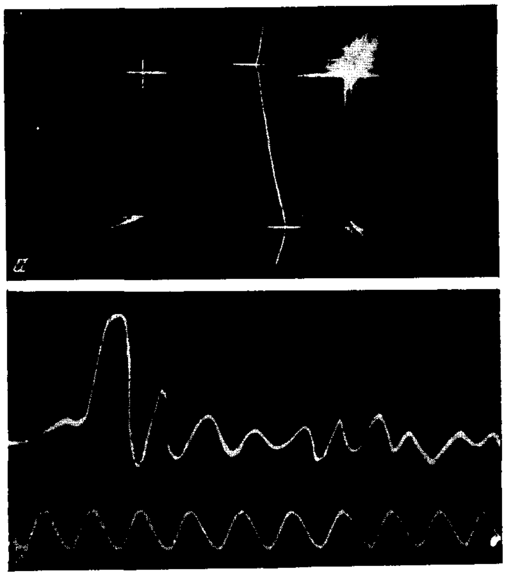

Fig. 3. Photograph of spark (a) and oscillogram of pulsed voltage (b). Frequency of time markers is 100 Mc.

The authors thank Corresponding Member of the USSR Academy A. I. Alikhanyan and Professor A. A. Vorob'ev for interest and collaboration, and Engineer M. I. Kozlov for help with the experiment.

[1] A. A. Tyapkin, Vestn. AN SSSR, No. 12, 1964.
[2] S. Fukui and S. Mijamoto, Nuovo cimento 11, 113 (1959).
[3] G. A. Vorob'ev and N. S. Rudenko, PTE, No. 1, 109 (1965).

DEPENDENCE OF THE REFRACTIVE INDEX ON THE DENSITY OF THE SOLID AND LIQUID PHASES OF SHOCK-COMPRESSED IONIC CRYSTALS. RELAXATION TIME OF PHASE TRANSFORMATION UNDER SHOCK COMPRESSION.

S. B. Kormer, K. B. Yushko, and G. V. Kirshkevich
Submitted 1 November 1965
ZhETF Pis'ma 3, No. 2, 64-69, 15 January 1966

The methods described in [1] were used to investigate the refractive indices of shock-compressed alkali-halide compounds. For LiF, which remains transparent in the investigated range of pressures up to $P \approx 700$ kbar, the refractive index was determined directly from the paths of the rays in the compressed matter. For NaCl, CsBr, KCl, and KBr crystals, which become opaque behind the shock-wave front 1) the refractive indices were determined by Fresnel's formulas from the experimentally-measured coefficients of reflection of natural light incident on the front of the shock wave.

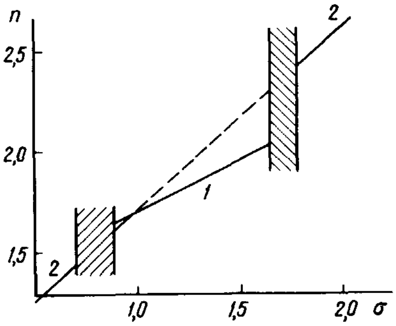

Fig. 1. Refractive index of ionic crystals vs. density in the solid and liquid phases

1. It turned out that the dependence of the refractive index on the degree of compression σ (where $\sigma = \rho/\rho_0$ is the running density and ρ_0 the density at $T = 300°K$ and $P \approx 0$) for the crystals LiF, NaCl, and CsBr, which do not experience polymorphic transformations in the investigated range of pressures, can be represented schematically as shown in Fig. 1 for the region $\sigma > 1$. So long as the shock compressed crystal remains in the solid phase 2), the refractive index will change relatively little with the density. Comparison of the values of

$$\frac{dn}{d\sigma} = \frac{n - n_0}{\sigma - 1} \qquad (1)$$

obtained for this range of compressions (n_0 = refractive index at $P \approx 0$ and $T = 300°K$), with the values of $(dn/d\sigma)_{\sigma=1}$ obtained [4-6] in investigations of the photoelastic properties of ionic crystals has shown that the function $n(\sigma)$ is linear over a rather broad range (see fourth and fifth lines of the table) 3).

It turned out further that the refractive index increases appreciably when the melting is in a compressed state (see Fig. 1). The experimental points obtained for the liquid phase of the crystals CsBr, KCl, and KBr fit the relation (1) quite well, but only if $dn/d\sigma$ is approximately 15 - 17 times larger than in the solid phase (see the table). We note that at normal pressure the change in density of the alkali halides in the liquid state changes the