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Abstract

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PHYSICS

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DESTRUCTION OF A LATENT PHOTOGRAPHIC IMAGE IN AN ELECTRIC FIELD

(Presented by Academician E. K. Zavoisky, January 17, 1967)

Layers of a type-P nuclear photographic emulsion, 50-400 μ thick, preliminarily exposed to charged particles of various energies, were subjected to pulsed and constant electric fields with strengths of 10^3 - $8 \cdot 10^5$ V/cm and were then developed in the usual way.

A uniform electric field was created in the space between two plane-parallel, carefully polished stainless-steel electrodes, $d = 40$ mm, with rounded edges. Emulsion layers without a support were placed between the electrodes. To create a constant field in the emulsion, the electrodes were connected to a high-voltage source. A pulsed electric field was created by a specially designed generator of high-voltage rectangular voltage pulses. The amplitude U and duration of the pulses T_i could be varied within the ranges $U = 0$ -30 kV; $T_i = 80$ -500 μ sec.

In a constant electric field, continuous branched formations arise in the emulsion on the cathode side; as the investigations showed, these consist of photolytic silver. The size, depth, and number of these formations (dendrites) per unit surface proved to be proportional to the duration and magnitude of the applied field. Dendrite formation occurs first of all at places with an increased field gradient owing to nonuniformities of the layer, the surfaces of the electrodes, or at places where an air gap is formed. The fact that the penetration depth of the dendrites in developed layers is greater than in layers fixed without development indicates the release of silver in emulsion grains remote from the electrodes in an amount sufficient to form development centers, but insufficient for direct decomposition of the grain (Fig. 1).

The low dielectric strength of type-P emulsion, caused by the high content of silver bromide, the presence of moisture, and other factors, does not allow a constant-field strength exceeding $2 \cdot 10^3$ V/cm to be created at room temperature.

Dendrites also arise in a pulsed electric field ($E \sim 10^5$ V/cm) when the pulse duration is not less than 1 msec. Any comparatively prolonged action of either a constant or pulsed electric field causes surface blackening (to a depth of up to 5

Fig. 1. Formations from photolytic silver (dendrites) in a type P emulsion under the action of a constant electric field for 10 min, $E = 10^3$ V/cm: *a*—after development and fixing; *b*—after fixing without development

Figure 1: Fig. 1. Formations from photolytic silver (dendrites) in a type P emulsion under the action of a constant electric field for 10 min, $E = 10^3$ V/cm: *a*—after development and fixing; *b*—after fixing without development

μ) of the emulsion layer on the cathode side. Surface changes are also observed on the anode side; these should be attributed to decomposition of gelatin.

Fields with strengths up to 10^5 V/cm have no effect on the latent image. At higher strengths, which can be produced in the emulsion only by short pulses of electric field not exceeding hundreds of microseconds, destruction of the latent image occurs. Thus, for complete destruction of relativistic tracks, repeated application of a pulsed electric field with a strength of—

Fig. 2. Destruction of the latent image of relativistic tracks in a type P emulsion under the action of a pulsed electric field, $E = 8 \cdot 10^5$ V/cm: **a** — relativistic tracks in the absence of a field; **b** —result of exposure to a series of rectangular electric-field pulses of duration 80 μ sec for 1 min at a frequency of 30 pulses/sec.

over $7 \cdot 10^5$ V/cm (on the order of 2000 pulses of duration $80 \div 500$ μ sec) (Fig. 2). A latent image formed by strongly ionizing particles (for example, α -particles) is destroyed only partially and is manifested in a decrease in the density of the tracks.

With a single exposure to light, produced synchronously with the application of an electric-field pulse, in Positiv M3 and FT-31 emulsions (^{1,2}) a decrease in the density of blackening was observed, analogous to the effect of destruction of the latent image.

The destruction of the latent image, formed both before and during the application of a pulsed electric field, apparently occurs for the following reason. Since the medium of a photographic emulsion is inhomogeneous, the creation in it of an electric field averaged over the layer thickness may lead to the appearance of higher field strengths—sometimes exceeding the average value by tens of times—in various local regions, especially at the boundaries of metallic inclusions, which may also include the silver centers of the latent image. The particular magnitude of the excess is determined by the shape and dimensions of the inhomogeneities (³). A high-intensity field ($\sim 10^7$ V/cm) can transfer an electron of some silver atom of the latent-image center into the conduction band of silver bromide; at the same time, this process will be accompanied by the departure of the resulting silver ion from the center under the action of the field. As a result of the action of one short electric-field pulse, the size of the latent-image center will decrease by at least one atom. If the center is sufficiently large, then its destruction requires the successive, repeated application of electric-field pulses.

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