aromatic substances, if account is taken of the high activity of these substances with respect to the reaction wherein an H atom is joined to an aromatic ring (the activation energy of the process is approximately 3 kcal/mole).

The results of the present communication and of [1] allow us to propose the following mechanism of H-luminescence of solid compounds with aromatic rings interacting with H atoms. The energy in the combination reaction (1) on the produced free radical is released in the form of electron excitation. If the excitation levels of the matrix lie above the excitation level of the radical, then the HL centers are the radicals. In this case, luminescence in the visible region corresponds to radiation close to resonant. In the case of a matrix whose molecules have low-lying excitation levels, energy is transferred to the matrix and radiation is observed in the photoluminescence band of the substance. Accordingly, the HL spectrum changes little when the PL is shifted if the PL spectrum lies in the region $\lambda_{PL} < 600$ nm, and coincides with the PL spectrum if $\lambda_{PL} > 600$ nm.

We note in conclusion that HL in dyes can be induced not only by a reaction of the type (1), but also by secondary reactions in which MH radicals take place: $H + MH \rightarrow M_1^*$.

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IONIZATION INSTABILITY AND MOTION OF GLOWING SPOTS IN Na_2ZnGeO_4:Mn CRYSTALS

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Na_2ZnGeO_4:Mn crystals were excited, just as in [1], by a dc voltage V at 50°C. It was observed that at V ≃ 1 kV (crystal length 5 - 6 mm) a bright green spot with dimension ∿0.5 mm is produced at the cathode; this spot moves to the anode at a velocity $\sim 4 \times 10^{-2}$ cm/sec. The current in this case is ∿10 μA and becomes unstable. With increasing V, several such spots are produced, and then entire glowing regions of quaint appearance become visible. The observed phenomenon obviously pertains to one of the forms of electric instabilities. The slowness of the motion of the glowing spot shows that deep levels take part in this process. Levels equal to ∿1 eV were found in these crystals by means of the photoconductivity spectrum. The sign of the thermoelectric power showed that the crystals were the n-type. The donor in them was Mn substituted for Na, which produced additional photoluminescence bands [2]. An estimate of the donor concentration N_d based on the relative brightness of these bands yields $N_d \simeq 10^{18}$ cm^{-3}. The acceptor may be the aluminum present in the crystals, if it is substituted for Ge. Then N_a is of the same order.

The recombination and temperature-electric instabilities are connected with recombination via the deep levels. However, they do not explain the observed phenomenon, since their occurrence requires continuous generation of free carriers of both signs. Thermal generation is completely excluded here,

since these crystals have a forbidden band E_g = 3.8 eV, and there is no pumping. Instead of using heat, the conductivity can be increased by illuminating the crystal with 1.2-eV quanta, but they cannot produce interband transitions.

The appearance of a slowly moving glowing spot can be attributed to the occurrence of a small region of strong field between layers of positive and negative charge. These charges are localized on the donors and acceptors. The electrons passing through the strong-field region can maintain these charges and cause impact ionization of the lattice. The holes produced thereby go out of the region of the strong field from the cathode side, and recombine there with the electrons, producing a visible glow.

Calculation shows that at the actual ratio of the spot dimensions to the crystal length, the voltage across a space-charge layer is approximately 0.05 V, i.e., ~50 V. The field in the layer reaches 2×10^6 V/cm. In such a field, the energy distribution of the electrons is determined by impact ionization of the lattice, since the rate of energy loss to phonon production is smaller by a factor of 100 than the rate of acquisition of energy in the strong field. On the path where the electron can acquire an energy sufficient for impact ionization of the lattice, the probability of its interaction with an impurity is only several per cent. According to calculation, the upper limit E_{max} of the distribution exceeds by 2 - 3 eV the threshold of the impact ionization and equals 6 - 8 eV. At such large values of E_{max}, the electrons can ionize the donors not only in the strong-field region, but also as they leave this region, although they rapidly lose the ability of ionizing the lattice because of the interaction with the phonons. An estimate shows that a hot electron can ionize a donor outside the strong-field region in a layer ~0.5 μ thick. This leads to propagation of the positive-space-charge layer in the direction of the anode. The lower limit of the distribution of the electrons can be estimated as follows. The electron produces impact ionization, having an energy excess ΔE over E_g amounting to several electron volts; this excess is shared by two electrons and a hole. An estimate shows that on the average there is 1 - 1.5 eV per particle. Thus, the average energy of the electrons in the strong field is $E_{av} \simeq$ 4 eV, and there are practically no thermal electrons.

Besides impact ionization of the lattice and of the donors in the strong field, impact ionization of the donors with threshold energy ~3 eV is also possible. At $E_{av} \simeq 4$ eV, its probability is comparable with the probability of impact ionization of the donors. Therefore in the region of the strongest field the number of electrons at the donors is determined by the competition between the impact ionization of the donors and their impact de-ionization. This leads to the appearance of a noticeable number of neutral donors N_d^0. A negative space charge is produced where N_d^0 does not exceed its equilibrium value. It therefore will occur again on the anode side relative to the already existing one, since the field is maximal precisely at the center of the double layer. At the same time, it will become gradually depleted on the cathode side, where the field is weaker, meaning that there is no impact de-ionization of the donors. Therefore the layers of charges of both signs will move towards the anode, and the glowing spot will follow them.

The occurrence of this spot at the cathode is brought about by the same mechanism as its motion. Indeed, in our experiments, there was apparently a barrier on the contact[1)], since the current-voltage characteristic was non-

[1)] We used contacts of the pressure type, as well as contacts of indium, aquadag, silver, and special conducting enamels.

linear even in the voltage region where there were no glowing spots. Therefore practically the entire voltage is concentrated at first at the cathode (since the crystals were of the n-type), and it is there that the strong-field region, in which all the processes in question begin, is produced. The contacts and the crystals themselves were not quite homogeneous over the surface. Therefore the concentration of the field may proceed at a faster rate in a small part of the region next to the cathode. It is in this part that the glowing spot is produced and then begins to move towards the anode. The spot may decrease in diameter as a result of edge effects. Some spots may become extinguished without reaching the anode, as was frequently observed in the experiment.

An independent check on the theory may be an estimate of the effective cross section of the donors S. It can be obtained if one knows the velocity of the moving spot, the current density in the spot, and the thickness of the layer outside the strong-field region in which impact ionization of the donors takes place. S was found to equal 3×10^{-14} cm^2. All the quantities needed for this estimate were found either from experiment or theoretically, but without any a priori assumptions concerning the parameters of the donors. Taking into account the accuracy with which these quantities were estimated, the obtained value of the donor-impact-ionization effective cross section can be regarded as perfectly reasonable.

Thus, the appearance and motion of glowing spots in Na_2ZnGeO_4:Mn crystals is connected with one more type of electric instability, characteristic of strongly compensated broad-band semiconductors with large concentration of deep donors. This instability can be called of the ionization type in view of the mechanism whereby it is produced.

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PROPAGATION OF MAGNETOPLASMA WAVES IN Bi ALLOYED WITH Te

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Among the various types of magnetoplasma waves propagating in a solid-state plasma (SSP), one distinguishes usually between Alfven waves, whose phase velocity v is proportional to the magnetic field H, and helicons, in which $v \sim \sqrt{H}$. The Alfven waves are observed at $\Delta N/N_\pm \ll \omega/\Omega_\pm$, and helicons at $\Delta N/N_\pm \gg \omega/\Omega_\pm$, where $N_\pm$ is the concentration of the carriers of opposite sign in the medium, $\Delta N = |N_+ - N_-|$, $\Omega_\pm = e_\pm H/m_\pm c$ is the cyclotron frequency, and ω is the wave propagation frequency. However, as indicated in [1], there should exist waves of an intermediate type propagating in the SSP under the condition $\Delta N/N_\pm \sim \omega/\Omega_\pm$.

For an experimental observation of the intermediate-type waves we used in the present investigation Bi samples doped with small amounts of Te. Te, being a donor impurity, gives up electrons, by the same token violating the condition $\Delta N = 0$, which is characteristic of pure Bi.

The experiments were performed at helium temperatures in constant magnetic fields of intensity up to 100 kOe [2]. The frequency of the incident wave was $f = 2.07 \times 10^{10}$ Hz. The samples were plane-parallel plates of thickness d = 0.6 - 1 mm with concentration 0.0006 and 0.0012 at.% Te. For comparison, we