UDC 621. 382

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SINGLE — JUNCTION TRANSISTORS CONTROLLED BY LIGHT AND MAGNETIC FIELD

Influence of magnetic field and light on current flow in silicon unijunction transistor was investigated. It is shown, magnetic field with induction B = 1T and radiation from *GaAs* light-emitting diode causes to the identical change of the base resistance and the current.

The action of magnetic field is substantially showed up in semiconductor transistors with long base, which work is based on injection of charge carrier [1]. Magnetic field bends their trajectory at transit of injected carriers and changes the length of their way. It causes the change in output current. The unijunction transistor (UJT) behaves to such type devices. It is a base semiconductor with two ohmic contacts and emitting *p-n*-junction between them. Charge carriers injected by emitter change base resistance and interbase current.

The industrial UJT (type KT 117) was used in the experiments. The cube structure and the input volt-current characteristics (VCC) are shown in Fig. 1. The connection scheme of the UJT is shown in Fig. 2 (here GC — current generator). e-b_1-contacts are input circuit, b_1-b_2-contacts are output circuit. Input VCC is the description of S-type with the part of negative differential resistance where input voltage decreases with current increase. From Fig. 1 it follows that resistance of input circuit R_{eb} increases with increase of magnetic field induction B. The dependence of resistance R_{eb} on induction B for current $I_e = 4$ mA is separately shown in Fig. 2. It should be explained as follows. The value R_{eb} consists of three resistances: *p-n*-junction resistor, bulk base resistance and b1-contact resistance. As the area of this contact is much less than the area of *p-n*-junction, R_{eb} is practically equal to flowing resistance of b_1-contact

$$r_{b_1} = \frac{\rho}{2\pi a},$$

where a — radius of contact, ρ — specific resistance of the base semiconductor [2]. For the given UJT it is equal to 200 Ohm cm. In absence of magnetic field ($B = 0$) the holes injected from the emitter pass to b_1-contact by the shortest trajectory. The value ρ near by it decreases and the value R_b-resistor is low. With increase of magnetic field indicated in Fig. 2 direction, the injected holes deviate by Lorenz force from b_1-contact to b_2-contact, their trajectory is lengthened. It results to decrease in concentration of holes, which reached b_1-contact, to increase in ρ and R_{eb}-resistance. When $B > 0.8$ T, holes practically do not reached b_1-contact and its resistance r_{b_1} stops to rise.

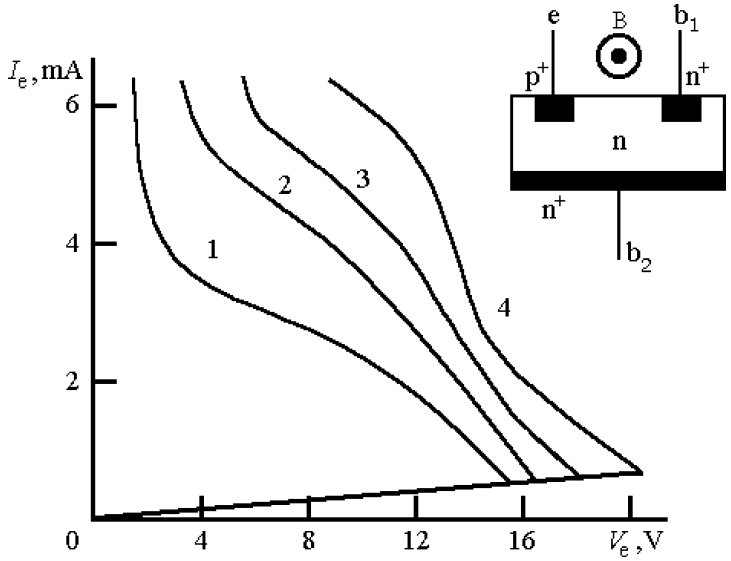

Fig. 1. Cubic construction and volt-current characteristics of UJT. Magnetic field inductance B, T: 1 — 0, 2 — 0.43, 3 — 0.83, 4 — 1.03

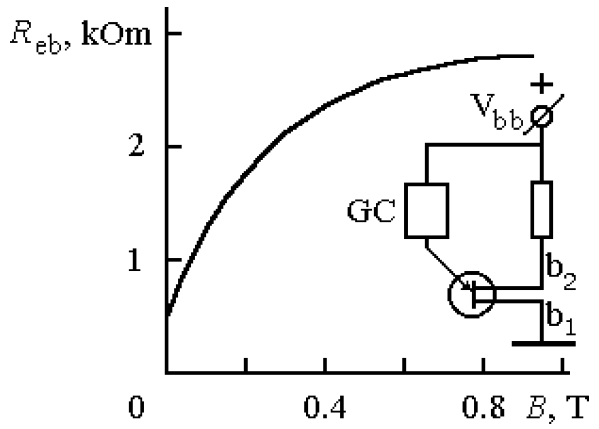

Fig. 2. Electric scheme of UJT and the dependence of circuit resistor Reb1 on magnetic field inductance B

The opposite effect takes place under illumination of UJT-base. The dependence of interbase resistance on feed current of *GaAs* light-emitting diode is shown in Fig. 3. The intensity of *GaAs* diode has practically depends linearly on current. As in any photoresistor, illumination increases the base concentration of current carriers and decreases their resistance. By comparison of Fig. 2 and Fig. 3 it is seen that magnetic field with inductance $b = 1$ T changes resistance in $4 \div 5$ times, as well as radiation of *GaAs* diode at its maximal current (30 mA).

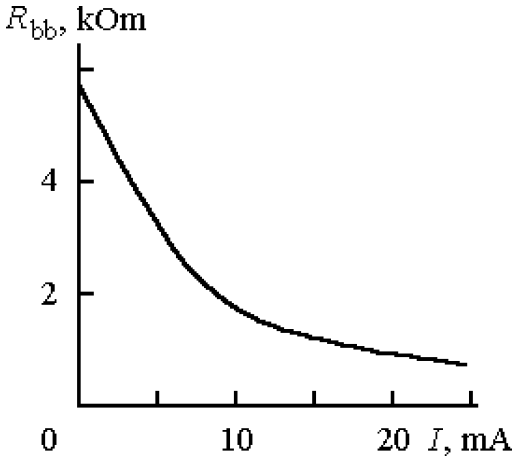

Fig. 3. Dependence of interbase resistor on current of GaAs light-emitter diode

Thus, the possibility of noncontact control for UJT parameters is developed. By similar way the characteristics of bipolar transistors and thyristors could be affected. The necessary condition to their construction is the requirement, that length of the base is comparable with diffusion length of injected charge carriers. In the practical devices the generator of the relaxation oscillation in UJT is used more frequently. For this case in the scheme of Fig. 2 it is enough to include the condenser between emitter and b_1-contact. As generator of current, the field transistor in bipolar connection is used (the control gate is closed with the source), for example, of type 2P202 or KP305 [2]. The frequency of generation is the function of light and magnetic field.

Such device can be used as radiation sensor, so as detector of magnetic field. At it use as the sensor of one value, for example, intensity of light, by change of other value (by magnetic field) it is possible either to change the sensitivity of sensor or to carry out its noncontact connection or shutdown. The double noncontact control in the parameters of transistors allows to extend considerably their functional possibilities and to multiply the reliability of work for these devices.

References

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ОДНОПЕРЕХОДНЫЕ ТРАНЗИСТОРЫ, УПРАВЛЯЕМЫЕ СВЕТОМ И МАГНИТНЫМ ПОЛЕМ

Исследовалось влияние магнитного поля и света на протекание тока в кремниевом одноперехoдном транзисторе. Показано, что магнитное поле с индукцией до 1 Тл и излучение от арсенидгаллиевого светодиода приводят к одинаковому изменению сопротивления базы и тока

УДК 621.382

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ОДНОПЕРЕХІДНІ ТРАНЗИСТОРИ, ЯКІ КЕРУЮТЬ СВІТЛОМ ТА МАГНІТНИМ ПОЛЕМ

Вивчався вплив магнітного поля та світла на протікання струму у кремнієвому одноперехідному транзисторі. Показано, що магнітне поле з індукцією до 1Тл та випромінювання від арсенгалієвого світлодіоду приводять до однакових змін опору бази та струму.