NEGATIVE RESISTANCE OF Bi-Bi_2O_3-Bi STRUCTURES

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Current-controlled negative resistance region were observed in the I-V characteristics of sandwiched Bi-Bi_2O_3-Bi structures, both at room temperature and at liquid nitrogen temperature. At higher applied voltages, multiple negative resistance regions accompanied by oscillatory variations were evident. Further increase of the external voltages seems to cause short – circuiting of the junction and ultimately cause reversal of the voltage polarities.

The thin Bi_2O_3 films have many applications in the various fields of technology microelectronics, magneto-optics, as functional elements [1-5]. We were observed negative resistance in the I-V characteristics of sandwiched Bi-Bi_2O_3-Bi structure. The method of preparing the samples has been reported in earlies our papers [6]. The schematic diagram of the experimental arrangement for tracing I-V curves is shown in Fig.1. Specially guarded and shielded circuitry in $X-Y$ recorder provides 1 MΩ input resistance at null on all fixed and variable ranges from 40 mV/cm and above. The current through the sample was obtained from the voltage drop against the standard resistance consists of manganin coils of 0,02% accuracy. Applied voltage across the junction was varied with the help of a rheostat.

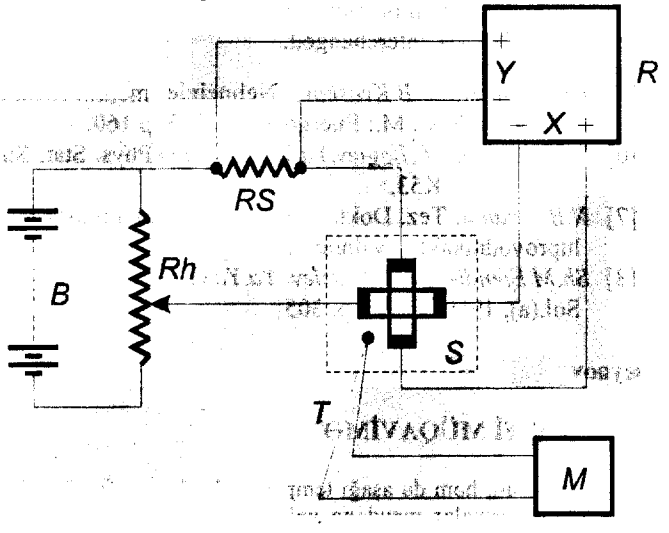

Fig.1. Experimental set-up used for tracing I-V characteristics (*S* - sample; *B* - battery; *Rh* - rheostat; *RS* - standard resistance; *R-x-y* recorder; *T* - copper-constantan thermocouple; *M* - microvoltmeter).

For measurements at liquid nitrogen temperature the samples was directly dipped into liquid nitrogen. For high temperatures the distance of the sample from the surface of liquid nitrogen was varied. Thermo emf of a thermocouple whose junction was kept near the sample was measured by a microvoltmeter.

Two typical I-V curved are reproduced in Figs. 2 (a) and (b). The negative resistance region in the curve at liquid nitrogen temperatures more prominent, showing in addition, some distinct oscillations. Generally, it was observed that the critical voltage at which the negative resistance region is higher at liquid nitrogen temperature than that at room temperature. Its value also depended on the aging of the sample, increasing together with one. Another interesting result exhibited by the sandwiched structures was that with further increase of applied voltage the easily recognizable additional negative resistance regions accompanied by high frequency oscillations were observed. This is displayed in the two typical curves reproduced in Figs.3 and 4. Hysteresis effect, particularly quite pronounced at room temperature, was also observed. Such negative resistance regions together with other ancillary effects have also been reported by several authors [7, 8].

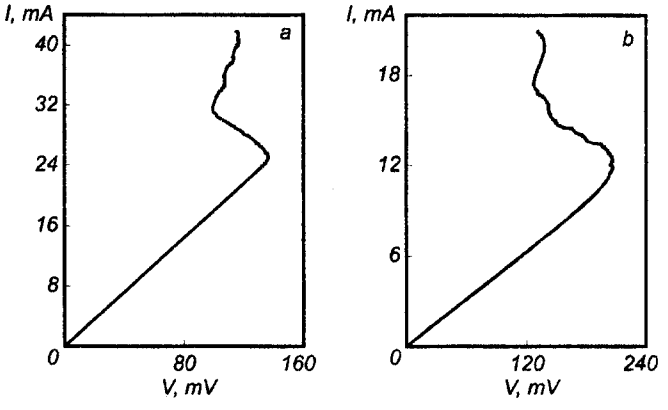

Fig.2. Tracing of I-V characteristics by $X-V$ recorder (a) at room temperature (300 K) after 23 hrs aging of the junction; (b) at 77 K after 23 hrs aging of the junction with area 0,01 cm^2.

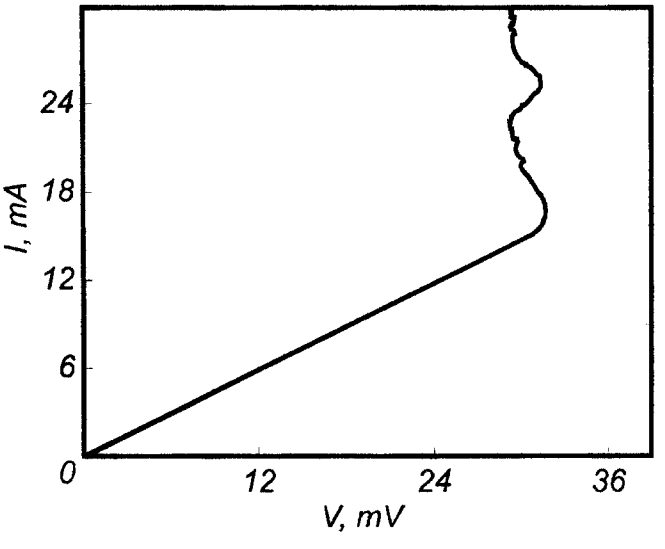

Fig.3. Recorder tracing of I-V curve, at room temperature showing multiple negative resistance regions (aging of the junction 4 days).

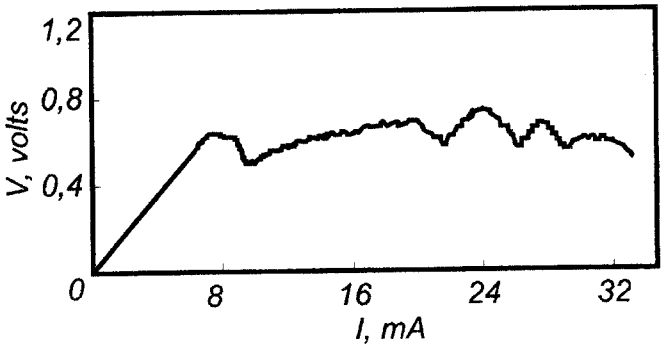

Fig.4. Multiple negative resistance regions as shown by the I-V curve at 163 K (aging of the junction 4 hr).

At room temperature, the voltage drop across the junction appeared to decrease at higher current and gradually became zero showing apparent short-circuiting of the junction. On further increase of the applied voltage, the I-V curves showed reversal of the voltage polarities across the junction, as shown by a tracing for a typical sample in Fig.5.

A slow 'memory' effect was exhibited by Bi-Bi_2O_3-Bi structures. It was observed in all the 50 samples studied so far that once the I-V curves were reserved to the negative direction, the samples had to have a minimum of 12 hr rest to get the I-V curves in the positive region. On repeating the experiment, however, the critical voltage at which negative resistance started was observed to be smaller.

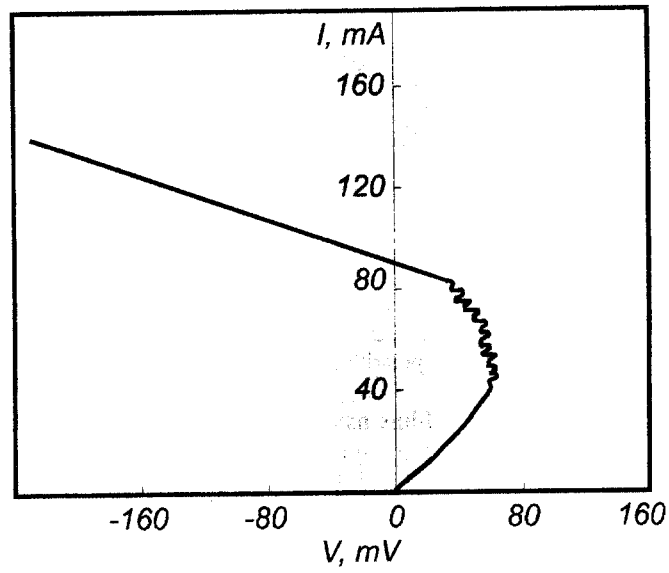

Fig.5. The reversal of I-V curve to the negative direction at room temperature (300 K) as the applied voltage whose positive terminal was being connected to the lower electrode Bi (aging of the junction 18 days).

All the curves reproduced here were traced with positive terminal of the applied voltage connected to the lower electrode bismuth. All the characteristics reported here were, however, observed to be more or less the same when the battery terminals were interchanged.

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Bi-Bi_2O_3-Bi STRUKTURLARINDA MƏNFİ MÜQAVİMƏT

Bi-Bi_2O_3-Bi sendviç strukturlarının volt-amper xarakteristikalarında həm otaq, həm də aşağı temperaturlarda mənfi müqavimət (MM) oblastı müşahidə olunur. Yüksək gərginliklərdə MM oblastında ossilyasiyalar meydana gəlir. Gərginliyin sonrakı artımı keçidin deşilməsinə gətirib çıxarır, hansı ki, ancaq əks gərginlik tətbiq olunduqda bərpa olunur.

Я.Ю. Гусейнов

ОТРИЦАТЕЛЬНОЕ СОПРОТИВЛЕНИЕ В СТРУКТУРАХ Bi-Bi_2O_3-Bi

Наблюдался участок отрицательного сопротивления (ОС) на вольт-амперной характеристике сэндвич-структур Bi-Bi_2O_3-Bi, как при комнатных температурах, так и при криогенных. При высоких напряжениях на участке ОС возникали осцилляции.

Дальнейшее увеличение напряжения приводило к пробою перехода, который восстанавливался только при обратном напряжении смещения.

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