THE EFFECT OF COPPER ADSORPTION ON SURFACE MOBILITY IN GERMANIUM*

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Abstract:

It has been demonstrated that copper adsorption on germanium surface from dilute aqueous solutions, results in reduction of surface Hall mobility of electrons on n-type specimens.

Subsequent hydrogen charging of the same surface leads to the neutralization of the effect of adsorbed copper on surface mobility.

1. INTRODUCTION

Considerable amount of work has been done in studying the effects of adsorption of metallic ions on surface trapping and recombination in germanium and silicon (see (1) and references therein). Some of the works have been concerned with the effects of copper adsorption from dilute aqueous solutions on surface trapping and recombination in germanium [2,3,4,5,6,7]. We have studied the effect of copper adsorption on surface mobility of electrons in accumulation layers on germanium. Our results clearly demonstrate surface mobility reduction following the adsorption of copper. We have also observed that hydrogen adsorption neutralizes the effect of adsorbed copper on surface mobility.

2. EXPERIMENTAL

Measurements have been performed on high resistivity n-type germanium specimens. Combined measurements of conductivity and Hall effect changes, effected by the

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field effect, have been made in the temperature range between 100 and 220 K. From these measurements, sets of data on surface Hall mobility μ_{ns} vs. ΔN have been obtained. First set of data was obtained for specimen surface etched in CP-4A, which we have used as a reference surface treatment. The next set of data was obtained with the same specimen after the adsorption of copper from 1 p.p.m. water solution of $Cu(NO_3)_2$.

Specimen was dipped for one minute in the solution[3], rinsed with ethanol and dried. Third set of data was obtained for the same specimen, but this time its surface was charged electrolitically with hydrogen, following the copper treatment. We employed 0.1N solution of HC1 and the cathodic treatment was carried on for 30 minutes, with constant current of 3 mA, using platinum plate as an anode[8]. Fig. 1 shows surface Hall mobility of electrons at 114.5 K for an etched surface and a surface after copper adsorption as a function of surface electron density ΔN. The reduction of surface mobility following the copper adsorption is clearly visible. On Fig. 2 surface mobility for an etched, copper treated and finaly hydrogen charged surface is presented vs. ΔN at T = 187.5 K. Here again, surface mobility has been reduced after copper adsorption, but the hydrogen charging seems to neutralize the effect of copper and mobility assumes higher values, close to the ones corresponding chemical etching.

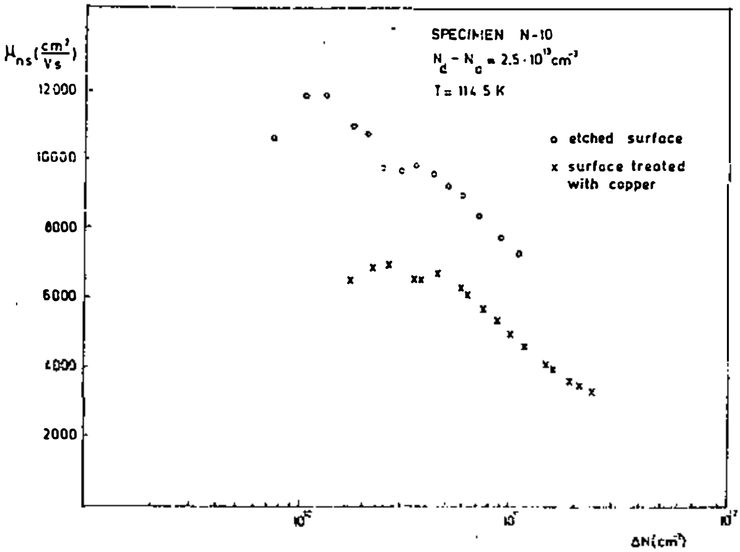

Fig. 1.

3. DISCUSSION

The reduction of surface mobility, following copper adsorption and shown on Fig. 1, appears at all temperatures between 100 and 220 K. A tentative explanation of our results rests on an assumption of Greene[9] that adsorbed impurities can act as surface scattering centers. Observations of Frankl[2,3] have also shown that copper on germanium induces additional trapping centers. Temperature dependence of mobility for fixed values of ΔN, shown on Fig. 3, exhibits a rise at the lower temperature range. Such behaviour has been attributed to carrier scattering on charged centers[10].

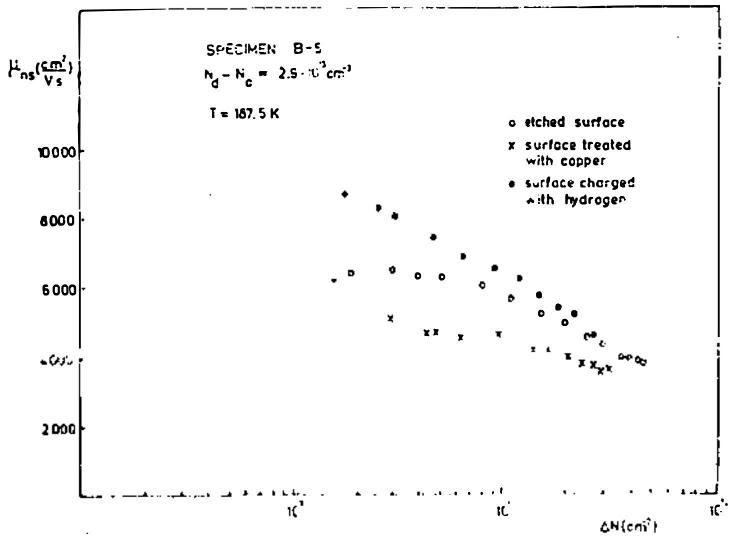

Fig. 2.

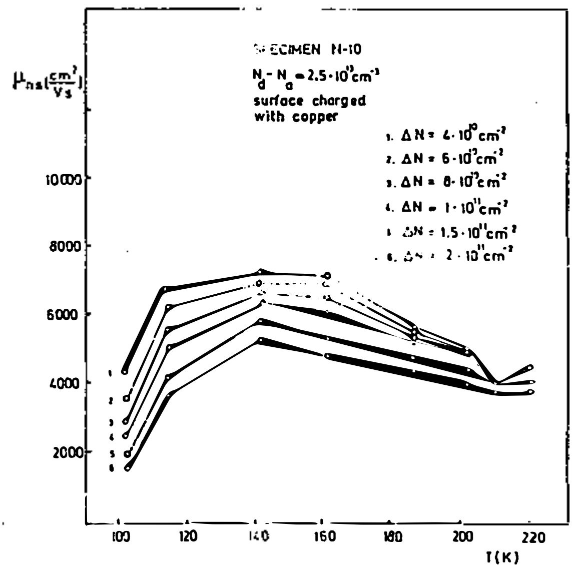

Fig. 3.

Considering the effect of cathodic charging on surface mobility following the copper treatment, one can draw an analogy with the neutralization effect of hydrogen on some bulk deffect centers[11,12]. It has been assumed for copper in bulk germanium that the hydrogen combines with copper and forms CuH_3 which is electrically neutral.

At present our results lack any data on surface scattering centers. We expect that additional experiments, combining galvanomagnetic measurements with C(V) measurements, might give us more information on the nature of surface scattering centers investigated in the present work.

4. REFERENCES

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