SPIN-LATTICE RELAXATION IN GLASSES

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I. INTRODUCTION

We have developped Electron T_1 measurements between 10 and 290 K in two kinds of glasses.

II. THE SAMPLES INVESTIGATED

i) Insulating glasses : silicate glasses doped with Fe_2O_3 (1%) and with Fe_2O_3 (0.5%) and Cr_2O_3 (0.15%).

ii) Semiconducting glasses : BaO, V_2O_5 doped with respectively 3% Fe_2O_3 (BVF1) ; 1% (BVF2) ; 0.5% (BVF3).

III. EXPERIMENTAL

We used an E.S.R. X-band spectrometer (1) using an amplitude modulated microwave field and the detection of the magnetization along the static field (dMz/dt).

IV. DATA FOR INSULATING GLASSES

$T_1^{-1} \propto T^{1.75 \pm 0.1}$ in both samples (figure 1), in good agreement with theories (2) (3). The relaxation is governed by phonons the electrical coupling is of dipole - quadrupole type. The spins are weakly coupled to a very large number of T.L.S. The doping with Cr_2O_3 produces no effect in agreement with BOGOMOLOVA (4).

V. DATA FOR SEMICONDUCTING GLASSES

i) BVF1 : $T_1^{-1} \propto T^{1.33 + 0.2}$. Spin fracton relaxation with the same electrical coupling as above (3).

ii) BVF3 : Two T_1 are encountered ($T'_1 \gg T''_1$). The behaviour is well accounted for by the BLOEMBERGEN and WANG three reservoirs model (5). In this sample V^{4+}-Fe^{3+} and Fe^{3+}-Fe^{3+} pairs have been evidenced (6) producing a high hopping electrical conductivity. The direct spin fracton relaxation is completely inhibited.

iii) BVF2 : The couplings are reduced by Fe-O-V and Fe-O-Fe bridges which begin to appear. Two T_1 are again present but the spin fracton relaxation ($T'_1{}^{-1} \propto T^{1.33}$) is now predominent while T''_1 is again observed.

When passing to BVF1, the couplings are strongly reduced by the bridges and the spin fracton relaxation is effective.

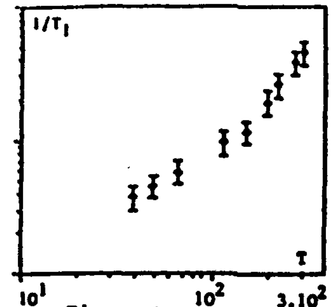

Figure 1

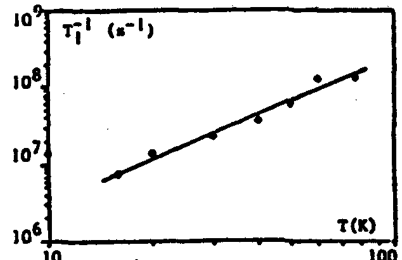

Figure 2

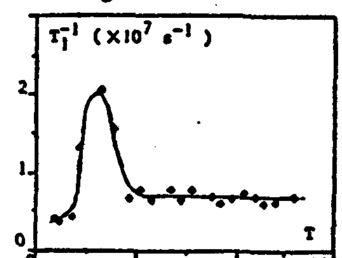

Figure 3-a

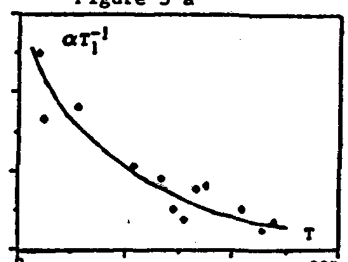

Figure 3-b

Relaxation in glasses :

Figure 1 : Insulating silicate glass
Figure 2 : Semiconducting glass BVF1
Figure 3 : Semiconducting glass BVF3
a-T'_1 b-T''_1

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