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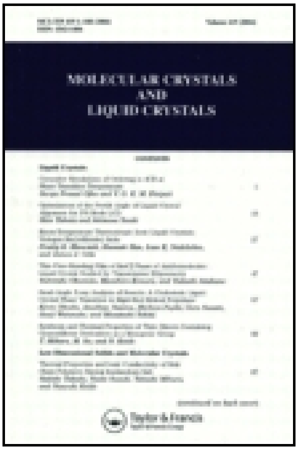

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Irradiation Induced Defects In The Blue Bronzes $K_{0.3}MoO_3$ AND $Rb_{0.3}MoO_3$

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IRRADIATION INDUCED DEFECTS IN THE BLUE BRONZES $K_{0.3}MoO_3$ AND $Rb_{0.3}MoO_3$

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Abstract We present results concerning the defect production by electron irradiation and the characterisation of the effects of the defects in the blue bronzes.

INTRODUCTION

The blue bronzes are recent additions to the family of compounds presenting collective charge density wave (CDW) transport[1].In order to learn about the role of lattice defects in such properties we have started to study electron irradiated samples in which the concentration of defects has been artificially increased. Already the first results indicated the interest of such studies: the threshold field of the non-linear CDW transport and the metastability were found to be very sensitive to irradiation[2].

IRRADIATION AND DEFECT PRODUCTION

Fast electron irradiation can produce defects in a solid by two basic mechanisms, either by displacing atoms in elastic collisions with the nuclei or by long-lived electronic excitations that induce local instability of the structure and, consequently, defect creation[3]. The first process is the usual one in case of covalent crystals or metals, the second in molecular structures or in case of ionic bonding. In materials such as the blue bronzes we cannot exclude 'a priori' either of the two processes,but our experimental observations are in agreement with the general behaviour of the displacement production. The defect production rate (Figure 1) decreases with decreasing energy of bombarding electrons, and seems to extrapolate to zero below a displacement threshold of about 150 keV. If electronic excitation processes were responsible for the defect creation one would not expect any threshold but on the contrary an increase of defect production rate with decreasing energy of incoming particles[3].

However, in a recent study Chen et al.[4] observed a destruction of the CDW diffraction satellite spots in the electron microscope, at electron energies as low as 60 keV. They concluded that electronic excitations can produce defects which perturb the CDW. Our results cannot exclude the existence of such a defect production mechanism but they clearly show that the displacement process is far more effective at high electron energies. In fact , in the electron microscope the dose necessary to destroy the CDW is of the order of 10 C/cm^2 at least. We expect to reach a similar effect with a dose about two orders of magnitude less using the high energy electrons, as it can be seen on Figure 2 that shows the CDW transition temperature as a function of the irradiation dose.

To get an idea of the defect concentration we have followed the increase of the intensity of a d-electron paramagnetic resonance line presenting a Curie like behaviour. Thus we obtain that a dose of 1 mC/cm^2 (about 6×10^{15} $elcm^{-2}$) of 2.5 MeV electrons increases the concentration of magnetic defects by 10^{-5} atomic fraction. The production rate of any non-magnetic defects is surely of the same order of magnitude. This observation was made after annealing at room temperature which decreases the effect and/or number of the defects as it will be seen in the following section.

THE EFFECTS OF THE IRRADIATION-INDUCED DEFECTS

A first impression on the effect of the defects is shown in the plot of the CDW phase transition temperature versus the irradiation dose, Figure 2. The important decrease occurs at the dose scale of a few hundreds of mC/cm^2 (i.e. $10^{-3}...10^{-2}$ at. fraction of defects), as it has been already observed for many other CDW-materials in the case of irradiation induced defects[5]. An anneal at 260 K helps to recover most of the decrease observed immediately after the irradiation. We can recall that spectacular changes in the non-linear CDW transport occur already at doses well below

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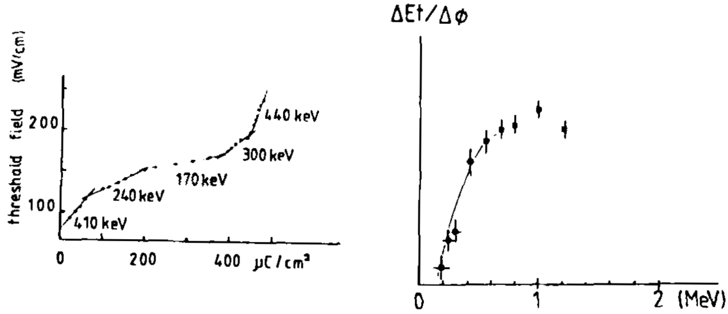

FIGURE 1 Variation of the threshold field Et of the non-linear conductivity (left) vs. dose at different energies gives us the damage production rate $\Delta Et/\Delta\phi$ as a function of the energy of the bombarding electrons (right).

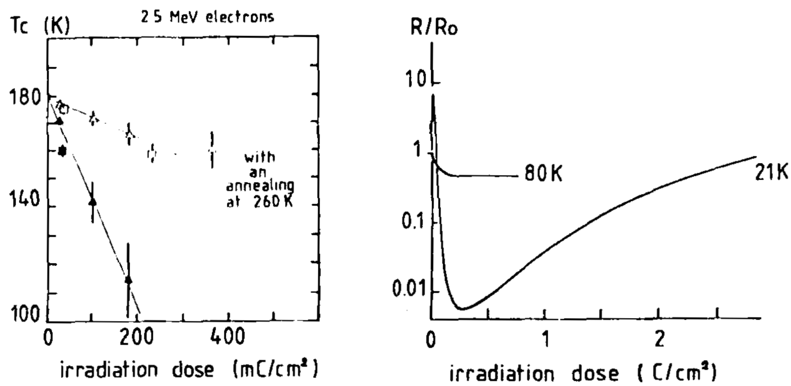

FIGURE 2 (left) Variation of the CDW transition temperature with irradiation dose.

FIGURE 3 (right) The low-field (single particle) resistivity as a function of irradiation dose at 21 and 80 K.

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1 mC/cm^2 when the critical temperature and, consequently, the average CDW amplitude are hardly affected at all.

The curves presented in Figure 3 show the variation of the low-field (single particle) resistivity during in-situ irradiation at 21 K and at 80 K. It can be seen that at the lower temperature changes in a range of three orders of magnitude can happen. The difference between the very start of the curves (a few 10 mC/cm^{-2}) is most probably due to the fact that the low temperature transport is dominated by the defect states of the electronic structure while at 80 K the transport is closer to intrinsic. However, at both temperatures the subsequent decrease of resistivity, well correlated with the decrease of the critical temperature (Figure 2), reflects the effect of defects on the CDW gap itself. The increase of the low temperature resistivity at doses exceeding 0.3 C/cm^{-2} occurs when the CDW gap is completely smeared, i.e. the phase transition no more exists. This effect is probably related to localization phenomena in the disordered metallic state stabilised by defects[5]. The general features of the resistivity behaviour reproduce those already observed in many CDW systems[5].

CONCLUSION

The results on the characterisation of the irradiation induced defects and their effects show clearly the interest of this kind of studies. Further work is in progress to understand better the role of lattice defects in the single particle and collective transport phenomena.

REFERENCES

1. C. Schlenker et al., in these proceedings
2. H. Mutka, S. Bouffard, J. Dumas and C. Schlenker, J. Phys. (Paris) Lettres, 45, L729 (1984)
3. L. Zuppiroli, in Défauts Ponctuels dans les Solides, Ecole d'Eté à Confolant (Editions de Physique, Orsay, 1978)
4. C.H. Chen, L.F. Schneemeyer and R.M. Fleming, Phys. Rev. B, 29, 3765 (1984)
5. L. Zuppiroli, H. Mutka and S. Bouffard, Mol. Cryst. Liq.Cryst. 85, 1 (1982)

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