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ESR PROPERTIES OF IRRADIATED $(TMTSF)_2ClO_4$

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Abstract We present the first ESR investigation of the irradiated $(TMTSF)_2ClO_4$. Irradiations induce disorder on the conducting chains that suppresses both SC and SDW phases. Above a defect concentration of 0.2 % of spins/mole of TMTSF, $(TMTSF)_2ClO_4$ presents the universal behavior of the strong irradiated 1D organic conductors.

INTRODUCTION

Recent works have been carried out to understand the effects of disorder on the low-T instabilities in $(TMTSF)_2ClO_4$. The disorder has been introduced on the anion chains by quenching (1) and by ReO_4^- doping (2), or on the conducting chains by $TMTTF^+$ doping (3) and by X-ray irradiation (4). In this contribution we present the effects of a controlled number of defects on the ESR properties of $(TMTSF)_2ClO_4$. Irradiations are performed at RT with a 100 keV electron-beam. The low dose effect demonstrates the high sensitivity of the R and Q-states to the presence of defects. At higher doses, this compound follows the same behavior than the other organic conductors.

RESULTS

Our experimental results are summarized in fig. 1, 2, 3. The susceptibility shows a low-T upturn following a $T^{-\alpha}$ law (α varying with the dose), which allows a determination of the defect concentration (fig. 1). A dose of 1000 Mrad corresponds to c = 1 % of localized spins per mole of TMTSF. At very low doses (c < 0.1 %),

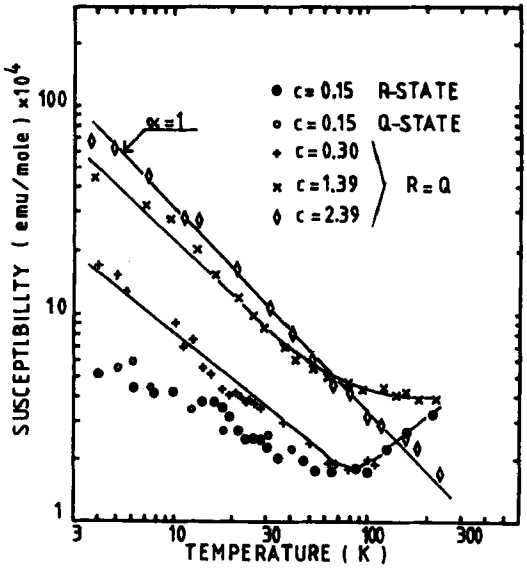

FIGURE 1 ESR susceptibility versus temperature for different defect concentrations (in % of spins/mole of TMTSF) in Log-Log scale.

there is no significant change for the susceptibility in the Q-state (Lorentzian line), except, of course, below 5 K where a ESR line appears after the first dose. The width of this line decreases with increasing c (fig. 2). On the contrary, the linewidth increases in the R-state. At the same time the $\frac{A}{B}$ ratio of the Dysonian line decreases from 2.5 to 1 for a defect concentration of about 0.2 %. At this point there is no more difference between rapid or slow cooling. Two ranges of defect concentration stand out from our results : below and above 0.2 % of spins per mole of TMTSF. We briefly discuss them successively.

c < 0.2 % of spins per mole of TMTSF

The variations occuring at low T are qualitatively understood as a gradual destruction of both 1-D instabilities by the growing on-chain disorder.

In the Q-state, the decrease of the linewidth (fig. 2) is

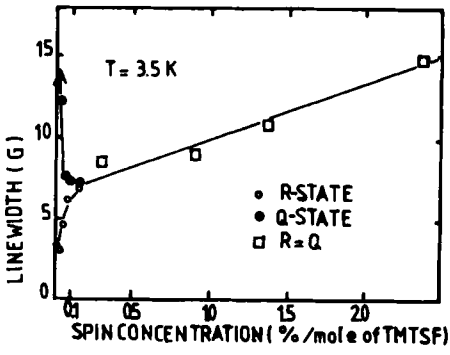

FIGURE 2 "Pic to pic" linewidth at 3.5 K versus defect concentration.

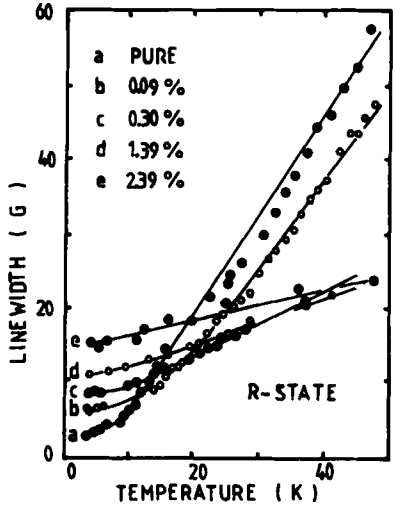

FIGURE 3 Linewidth versus T for different defect concentrations in the R-state.

related to the lowering of the SDW transition temperature. The on-chain defects destroy the 3D ordering of the SDW (6).

In the R-state, the noticeable point is the very rapid increase of the linewidth with c, compared to the high dose regime (fig. 2). This broadening of the line and the rapid decrease of the $\frac{A}{B}$ ratio, which indicates a strong variation of $\sigma_\perp$, reflect the extreme sensitivity of the R-state to the presence of irradiation induced defects.

c > 0.2 % of spins per mole of TMTSF

There is no more difference between rapid or slow cooling. That is in agreement with the results of Moret and al (4), which observe a complete anion disorder at doses of the same order of magnitude. The EPR characteristics are typical of the strong irradiated 1D compounds (5), namely the linewidth increases with c at low T and decreases at high T (fig. 3) ; A $T^{-\alpha}$ law emerges at low T, with α slowly increasing with c until $\alpha \simeq 1$ when the Curie tail extends

up to room temperature. At this time, the unaffected RT-susceptibility begins to decrease, suggesting a recombination of the spins induced by irradiation (fig. 1). All these effects are understood within a model of metallic segments (5).

CONCLUSION

This experimental work, with this future extensions, will allow us to understand how the disorder acts on the electronic properties and on the 1D instabilities in $(TMTSF)_2ClO_4$.

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