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# Influence of The Disorder on the ESR Linewidth of the Organic Conductors

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# INFLUENCE OF THE DISORDER ON THE ESR LINEWIDTH OF THE ORGANIC CONDUCTORS

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Abstract We present new ESR experiments on several irradiated organic conductors. A large range of defect concentration has been investigated up to a ten of %. The results concerning the different compounds are discussed within the frame of metallic segments. Irradiations allow a clear separation of the spin-lattice and spin-spin relaxation which usually act in parallel.

## INTRODUCTION

For several years, systematic irradiation experiments have been performed on various 1D conductors. The influence of the defects on the transport properties has clearly demonstrated that irradiation induced defects can be viewed as strong potentials that break the conducting chains into segments[1]. However the magnetic properties of the conduction electrons in the irradiated compounds have not been investigated systematically except for the case of the $Qn(TCNQ)_2$ [2] and for the low-temperature magnetic susceptibility and its unusual $T^{-\alpha}$ laws[3]. We present the recent developments of the previous work published in the conference in les Arcs[4]. The experiments are extended to other compounds and to larger defect concentrations. We emphasize here the general behaviour of the ESR linewidth in the metallic state as a function of the defect concentration and derive a picture of metallic segments which includes all the studied compounds (even the $Qn(TCNQ)_2$).

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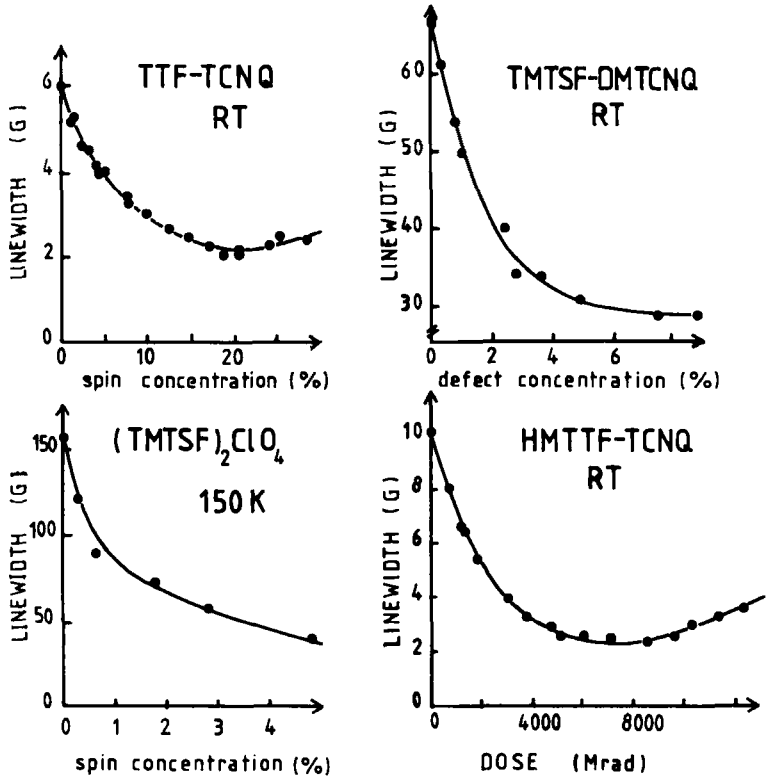


FIGURE 1 The linewidth is shown as a function of the spin or defect concentration for 4 typical compounds at room temperature (150 K for $(TMTSF)_2-ClO_4$). The spin concentration is determined by the low-T susceptibility and the defect concentration by the conductivity measurements.

## RESULTS

The figure 1 shows the variation of the ESR linewidth at fixed temperature in the metallic state (well above any transition), as the concentration of the irradiation induced defects increases. The noticeable point is the decrease of the linewidth with increasing c

whatever the compound is. One should also notice that the g-factors and the ESR susceptibility in this metallic range are unaffected by the presence of irradiation induced defects, except for the highest doses when the Curie tail (or $T^{-\alpha}$ law) reaches the temperature of measurements. At this point, the linewidth increases with c on the whole T-range. One should note that at these high defect concentration all the compounds present similar behaviours : the linewidth increases on cooling and when the degree of disorder increases, and the low disorder $T^{-\alpha}$ law becomes a Curie law (for the case of $Qn(TCNQ)_2$, the linewidth does not present the initial decrease[2]).

## DISCUSSION

To take in account the variations of the linewidth on the whole concentration range we should considere two types of spin relaxation :

- the first is the spin-lattice relaxation related to the electron orbital momentum scattering through the spin-orbit coupling. That is the dominant process for the CESR line in the pure isotropic metals[5] ($\Delta H \sim \frac{(\Delta g)^2}{\tau e\text{-}ph}$ Elliott relation). To take into account the one dimensionality, Weger has proposed that the spin scattering time is related to the electron transverse hopping frequency[5] ($\tau_\perp^{-1}$) so $\Delta H \sim (\Delta g)^2 \tau_\perp^{-1}$. This formula accounts for the order of magnitude of the linewidth. Our irradiation experiments are another proof of the validity of this equation. In fact conductivity measurements have shown that transverse diffuse conductivity becomes a fixed-range hopping conductivity between adjacent segments created by irradiation[1]. So the transverse hopping frequency is reduced by a factor $\tau_\perp^{-1} = \tau_{\perp o}^{-1} \exp\left(-\frac{Ec}{kT}\right)$ and consequently the linewidth is also decreased exponentially when the defect concentration increases. One should notice that the coefficient E is found to be the same for the conductivity and magnetic experiments.

However, a second spin flip mechanism has to be introduced in order to explain the saturation and the increase of the linewidth

at high doses. This mechanism is the result of many relaxation effects which do not involve itinerant electrons (as far as these relaxations are concerned, the effects of the electronic motion are treated as motional (exchange) narrowing). These contributions have been extensively treated for the case of pure and irradiated $Q_n(TCNQ)_2$ [2,6]. The similarities between TTF-TCNQ and $Q_n(TCNQ)_2$ containing the same amount of defects permit to extend this treatment to the irradiated TTF-TCNQ. In this model, the most important relaxation emerges from dipolar interaction between spins localized on adjacent segments (with strong motional and/or exchange narrowing). The effects of the irradiation are at least to increase the number of such segments and so the dipolar interaction. Moreover, the motional narrowing is reduced by the increase of the electron localization. So the corresponding contribution to the linewidth is expected to increase with c and with decreasing T. However, the single lorentzian line found in all the defect concentration range indicates that spins are not separated in two independent families but that both mechanism act in parallel.

## CONCLUSION

By considering these two contributions (a spin-lattice relaxation and a dipolar interaction) we are able to describe the defect concentration and the temperature dependence of the linewidth for all the compounds studied up to now.

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