

**MOLECULAR MATERIALS AND LOW-FIELD ESR  
- APPLICATION TO MAGNETOMETRY -**

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The development of the magnetometry by esr has been made in three steps : the design of a low-field spectrometer, the optimization of various magnetic materials and finally their use in a earth-field magnetometer.

The purposes of the spectrometer is twofold : i) to characterize the performances of the synthesized materials for their applications in magnetometry ; ii) to dispose of a performant low-field spectrometer for physical applications (frequency dependence, superconductor, ...). Some highlights have thus been pointed out for the design : i) dc magnetic field close to the earth-field (i.e. 40 A/m  $\approx$  1 oersted) ; ii) characterization of small quantities of material ; iii) output parameters independent of the measurement channel ; iv) the use of a figure of merit which must be defined to class the materials. The coil setup surrounding the sample has been chosen to be in the Bloch configuration [1]. For convenience a field sweep has been used, the frequency being maintained constant at 1.845 MHz where no significant disturbance appears. (A detailed description will be published elsewhere [2]).

To compare performances of the materials a possible figure of merit is the slope of the derivative of the esr absorption line. In the linear range of the response on the hf magnetic field  $H_1$  and on the dither modulation  $H_m$ , the slope  $S_0$  may be approximated by [2] :

$$S_0 \approx \chi_0 P T_2^3 H_1 H_m.$$

where  $\chi_0$  is the spin susceptibility and  $T_2$  is the electronic spin-spin relaxation time. By optimizing  $S_0$  with respect to  $H_1$  and  $H_m$  [3,4], one obtains:

$$S_2 \approx \chi_0 P T_2^{3/2} T_1^{-1/2}$$

and for the approximation  $T_1 \approx T_2$ , this yields a linear dependence upon  $T_2$  :

$$S_{max} \approx \chi_0 P T_2 \quad (1)$$

Materials suitable for magnetometry should exhibit a high susceptibility and a very narrow esr line ; only  $\pi$ -systems are then considered i.e. radical-ion salts, neutral radicals or doped conjugated polymers. The results summarized in the Table, concern the quinolinium salt of TCNQ, a fluoranthenyl salt, phthalocyanine radicals and doped polyacetylene. The slope evaluated by equation (1) with a maximum packaging,  $P$ , is compared to the experimental one obtained with the described low-field spectrometer. Values are normalized to that of Quinolinium-TCNQ<sub>2</sub> salt considered as a reference.

	Evaluated	Experimental
Q-TCNQ <sub>2</sub>	1	1
FARK	2.28	3.07
PcLi	0.51	0.42
(MeO) <sub>8</sub> PcLi	0.11	0.6
doped (CH) <sub>x</sub>	0.013	0.012

[1] F. BLOCH, W.W. HANSEN and M. PACKARD, Phys. Rev., 70, 474 (1946).

[2] D. DURET, M. BERANGER, M. MOUSSAVI, Ph. TUREK and J.-J. ANDRE, Synth. Met., 27, B175 (1988) and to be published.

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