A2 /11

ELECTRONIC PROPERTIES OF F CENTERS IN ALKALI HALIDES STUDIED BY OPTICAL DETECTION OF MAGNETIC RESONANCES (EPR, ENDOR, NMR)

M.A. Aegerter

Institut de Physique, Université de Neuchâtel, 2000 Neuchâtel (Switzerland)

The study of electronic properties of F centers in alkali halides has been recently revived by the use of different high resolution techniques of optical detection of magnetic resonances. One of them uses the interesting property of concentration quenching of the F center luminescence. This phenomenum plays a major role in most luminescent system and is generally due to some interaction between pair of defects.

In alkali halides isolated F centers optically excited can only return radiatively to their ground state ($\eta = 1$). However when two F centers are close enough to each other the excitation of one member of the pair leads after relaxation either to a radiative or to a non-radiative process. The physical nature of the non-luminescent disexcitation is still not well understood. We have proposed that a covalent bonding of the pair in its relaxed excited state may favour a spontaneous lattice distortion and bring the pair in its ground state without photon emission[1]. On the other hand the transient formation of F center via a non-radiative electronic transfer $\bar{F}^{*}-F_o \rightarrow F^{+}+F^{-} \rightarrow F_o+F_o$ has been experimentally observed under certain conditions. Both processes depend on the spin symmetry of the F center pairs which is determined by the competitive influence of different magnetic interactions (e.g. local hyperfine fields, exchange spin-spin interaction, external magnetic field, etc.). Any variation in one of these interactions modifies the probability of the non-radiative disexcitation process and can be therefore detected as a change in the radiative quantum yield of the F center luminescence. The validity of this pair model is quantitatively confirmed by studying the variation of the F center luminescence intensity as a function of an external magnetic field for different state of aggregation.

Moreover microwave transitions (EPR) induced between the spin levels of F center pairs modify their population and consequently change the relative probability of the disexcitation processes. EPR occurs either in the ground state or in the relaxed excited state of the pairs and it can be revealed by just monitoring the corresponding change in the luminescence intensity[2].

All these phenomena are strongly sensitive to the F center pair separation. This dependence can be described by an exchange spin-spin interaction $J\, \vec{S}_i \cdot \vec{S}_j$ mainly effective in the relaxed excited state of the pairs[3]. As the pair separation diminishes it will be shown that the optical and magnetic properties of these F center pairs become favourable to perform ENDOR and NMR spectroscopy detected by using the same optical technique. Recent results will be discussed and explained quantitatively.

This work was supported by the Swiss National Foundation for Scientific Research.

REFERENCES

1) C. Jaccard and M. Aegerter, Phys. Letters 44A, 391 (1973

2) Y. Ruedin, P.A. Schnegg, C. Jaccard and M. Aegerter, Phys. Stat Sol. (b) 54, 565 (1972) and (b) 55, 215 (1973)

3) P.A. Schnegg, C. Jaccard and M. Aegerter, to appear in Phys. Stat Sol. (b) 63 (1974); see also the abstract in this book (P.A. Schnegg et al.).

A2/L