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Magnetic field effects on the F and F' centers in NaBr and NaI

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Résumé. — Les centres F dans NaBr et NaI se comportent de la même façon que dans les autres halogénures alcalins, si ce n’est que l’absorption F’ se situe vers les hautes énergies de la bande F, et que les centres F’ restent stables dans l’obscurité jusqu’à 200 K. Ces deux anomalies ont conduit à émettre quelques doutes sur la nature F’ de cette absorption. Afin de clarifier ce point important, nous avons effectué quelques mesures sous champ magnétique de la conversion F → F’, qui devrait disparaître dans ces conditions. Les mesures effectuées à basse température, ~2 K, et sous champs magnétiques allant jusqu’à 80 kG, montrent une forte réduction de cette conversion dans les deux matériaux, confirmant ainsi la nature F’ de cette bande.

Recently [1] the luminescence of F centers in NaBr and NaI, consisting of two peaks in the near IR, have been measured for the first time. F centers in these two crystals behave like in the other known host alkali halides, except that the F’ absorption lies on the high energy side of the F band and the F’ centers are stable in the dark up to ~200 K. These two anomalous properties have cast some doubts on the F’ attribution for this absorption. In order to clarify this important point we have made some measurements of the optically activated F → F’ conversion in a magnetic field. It is well known [2] indeed that the formation of F’ centers in the ground state with antiparallel spin configuration is suppressed in a strong magnetic field. We have made measurements in both NaBr and NaI crystals at low temperature, ~2 K, and in magnetic fields up to 80 kG. The F centers concentration, ~5 × 10¹⁶, was enough to have in zero field a sizeable F → F’ conversion. The experimental results indicate a strong reduction of the above conversion, to ~10% of the initial value, in NaBr and a partial one, ~50%, in NaI. In both cases the relative quantum efficiency of the conversion versus the magnetic field is fitted well by a model [2], which admits the existence of a bound triplet state, with parallel spin configuration, for the F’ center. However it is our opinion that also a possible loss of spin memory during the optical cycle [3] could give a satisfactory explanation to our experimental results.

It is evident that further studies are needed for a better understanding of these interesting properties.

DISCUSSION

Question. — D. Y. Smith.

Have you attempted to follow the F → F’ conversion process by monitoring the α and β bands?

Appearance of an α band would indicate the production of halide-ion vacancies and would be evidence for the trapping of the excited F center electrons elsewhere in the crystal.

Reply. — G. Baldacchini.

No. But I agree that it would be useful. However I wish to mention that the crystals we used have a strong U absorption and that could partially overlap the α band.

Question. — R. H. Bartram.

Did you observe any effect of the magnetic field on the efficiency of fluorescence?

Reply. — G. Baldacchini.

No. At the moment we cannot measure the luminescence, but we plan to do something in the future.

References


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