Thermoluminescence of alkali halides doped with alkaline earth impurities

A R LAKSHMANAN and S V MOHARIL*

Division of Radiological Protection, Bhabha Atomic Research Centre, Bombay 400 085, India

*Department of Physics, Nagpur University, Nagpur 400 010, India

MS received 31 March 1986; revised 12 May 1986

In this note we elaborate some points on LiF mentioned in the review article on "Thermoluminescence of alkali halides doped with alkaline earth impurities" by Deshmukh and Moharil (1985), hereafter referred to as paper I.

(1) The last sentence in § 3.1 of paper I states "In recent years, the 285°C peak has been correlated with the 310 nm band (Lakshmanan *et al* 1982)". This should read as "In recent years, the 285°C peak (peak No. 7 according to the notation of Sunta *et al* 1971) has been correlated by Lakshmanan *et al* (1982) with two-electron centres". Lakshmanan *et al*'s (1982) studies have shown that there is a trap conversion between peak 7 and 450°C (peak 10) centres just as one would expect from $Z_2 \rightleftharpoons Z_3$ trap conversion. This has prompted them to suggest that peak 7 correlates with Z_2 centres; not to be confused with 310 nm band as assigned by Nink and Kos (1976). Peak 7 optical absorption (OA) is not yet identified unambiguously because of the presence of intense F(250 nm) band.

Mayhugh (1970) established that the 200°C TL peak (peak No. 5) corresponds to the 310 nm OA band. It is now generally agreed that Nink and Kos's (1976) identification of 310 nm OA with Z_2 centres in LiF:Mg, Ti is not correct (Jain and Kathuria 1978; Nepomnyashchikh and Radzhabov 1980; Horowitz 1982; Caldas *et al* 1983; McKeever 1984; Lakshmanan 1984).

(2) Mort (1966) and Mort and Zimmerman (1966) empirically predicted the Z_3 centre absorption maximum at 225 nm in LiF:Mg. Nepomnyashchikh and Radzhabov (1980) again predicted the absorption of Mg^0 type centres from semi-empirical relation at 225 nm. Lopez and Lopez (1981) predict that Mg should act as an electron trap. On the contrary, Bosi and Nimis (1985) in a recent analysis predict that Mg should form Z centres in LiF. All these diverse predictions show that such an analysis is premature.

(3) The arguments concerning 310 nm $\rightarrow$ 225 nm conversion during low temperature optical bleaching and the correlation of 310 nm and 225 nm OA bands with Mg^+ and Mg^0 centres by Nepomnyashchikh and Radzhabov (1980) (refer § 4.1) have been questioned recently by Lakshmanan *et al* (1985). If the argument that all Mg^+ centres change to Mg^0 centres when peak 5 readout is correct, then one should not have observed peak 5 at all. Even if one assumes that only some Mg^+ centres change to Mg^0 centres, then the peak 10 (correlated with 225 nm OA) TL in virgin LiF TLD-100 should have been considerably greater than that for the 140°C pre-irradiation annealed sample, because peak 5 (correlated with 310 nm OA) TL traps

and hence the electrons released from them are a factor of 20 to 30 times higher in the former sample than in the latter one. But experiments show no appreciable difference in peak 10 TL between the two samples (Lakshmanan *et al* 1985).

(4) In §4.1 of paper I, it is also mentioned that ESR measurements by Watterich *et al* (1980) show that in LiF:Mg, the g value is 2.006 for the F band and 2.029 for the 225 nm band suggesting that the latter is not a Z_3 band. Nevertheless, this band seems to be definitely related to the presence of Mg. Subsequently Watterich *et al* (1984) stated that the presence of OH in LiF:Mg made the ESR investigation of any Mg^+ ions impossible upto now.

Landreth and McKeever (1985) have recently reported that from their optical absorption data on LiF:Mg,Ti, they find no compelling evidence to relate either the 4.4 eV or the 5.3 eV bands to Z-type centres. The 5.7 eV may be a Z-type defect but of unknown structure. Hence more detailed experimental studies including optical absorption, ESR, ENDOR, Faraday rotation etc are needed to identify the TL trap centres bearing in mind that the behaviour of LiF could be different from other alkali halides.

As mentioned in paper I, the ultimate photon emission step is not satisfactorily elaborated in any of the models in literature. The mobile electron and mobile interstitial models have led to two groups of researchers, each proceeding almost independently and ignoring the work of the other. The recent article by Lakshmanan *et al* (1985) attempts to answer these questions in LiF TLD-100 and suggests that both the processes may be operating at the same time.

References

- Bosi L and Nimis M 1985 *Phys. Status Solidi* **B131** K111
 Caldas L V E, Mayhugh M R and Stoebe T G 1983 *J. Appl. Phys.* **54** 3431
 Deshmukh B T and Moharil S V 1985 *Bull. Mater. Sci.* **7** 427
 Horowitz Y S 1982 *Phys. Status Solidi* **A69** K29
 Jain V K and Kathuria S P 1978 *Phys. Status Solidi* **A50** 329
 Lakshmanan A R, Chandra B and Bhatt R C 1982 *J. Phys.* **D14** 1683
 Lakshmanan A R 1984 *Radiat. Prot. Dosim.* **6** 52
 Lakshmanan A R, Bhuwan Chandra, Bhatt R C, Hoffmann W and Spallek R 1985 *J. Phys.* **D18** 1673
 Landreth J L and McKeever S W S 1985 *J. Phys.* **D18** 1919
 Lopez F and Lopez F A 1981 *Cryst. Lattice Defects* **9** 131
 McKeever S W S 1984 *Radiat. Prot. Dosim.* **8** 3
 Mayhugh M R 1970 *J. Appl. Phys.* **41** 4776
 Mort J and Zimmerman D W 1966 *Phys. Lett.* **21** 273
 Mort J 1966 *Phys. Lett.* **21** 124
 Nepomnyashchikh and Radzhabov E A 1980 *Opt. Spectrosc. (USSR)* **48** 154
 Nink R and Kos H J 1976 *Phys. Status Solidi* **A35** 121
 Sunda C M, Bapat V N and Kathuria S P 1971 *Proc. Third Int. Conf. on Lum. Dosimetry*, Riso Report No. 249, Danish AEC and IAEA p 146
 Watterich A, Foldvari I, Corradi G and Opyrchal H 1984 *Phys. Status Solidi* **B121** 117
 Watterich A, Foldvari I and Voszka R 1980 *J. Phys. (Paris)* **41** C6-159