" Role of Secondary Interstitial Processes on the Structure of the F Colouring Curve in Alkali Halides "

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Recent experimental evidence seems to support the view that Frenkel pairs are created by ionizing radiation throughout the colouring curve even at very low dose where the initial impurity-controlled stage is observed. This fact suggests that the various stages appearing in the F-centre growth curve as well as the role of a number of factors suchs as radiation intensity, chemical impurities, mechanical and thermal pre-treatment and, in some way, temperature, have to be attributed to secondary processes of interstitial trapping, recombination or aggregation.

The purpose of this communication is to show that if one takes into account the interstitial-interstitial aggregation in addition to the previously assumed interstitial-vacancy recombination and interstitial-impurity trapping, it is possible to understand qualitatively the whole structure of the F colouring curve and its dependence on various physical factors. Detailed calculations with the equations proposed in a previous letter[1] have been performed with an IBM 7090 computer.

In accordance with the experimental data, the "model" curves show a rapidly growing initial stage (stage I) associated to trapping of free interstitials by saturable traps[2] (very likely impurities), and an essentially flat region (stage II) due to the dominant interstitial-F centre recombination once the traps have been exhausted. At higher dose a region of increasing F-centre production rate appears which finally leads to the so-called intrinsic stage (stage III). The occurrence of stage III corresponds to the nucleation of interstitial aggregates through interstitial-interstitial aggregation and the subsequent operation of these aggregates as the non-saturable traps postulated by Durand et al.[3]

The effect of radiation intensity can be easily taken into account and the results obtained are in substantial agreement with experimental data on NaCl, KCl and KBr. On increasing radiation intensity the length of stage II becomes progressively shorter and a more abrupt transition from stage II to stage III is obtained, fig.1. This is related to the increase in the rate of interstitial aggregation as a consequence of the higher instantaneous population of free interstitials.

The effect of prior doping with interstitial-trapping impurities can also be qualitatively explained. The model predicts a marked increase in the saturation of the initial stage and a extremely flat stage II whose length increases with trap concentration, fig.2.

Stage III behaviour is not observed, at moderate dose, in heavily doped crystals as it has been often found in previous work. Similar results apply to crystals which have been plastically deformed or quenched before irradiation.

Finally, experimental data on the γ-irradiation hardening of NaCl as a function of dose are also in agreement with the scheme presented here. They have shown the different interstitial configurations appearing during the various stages of the colouring.

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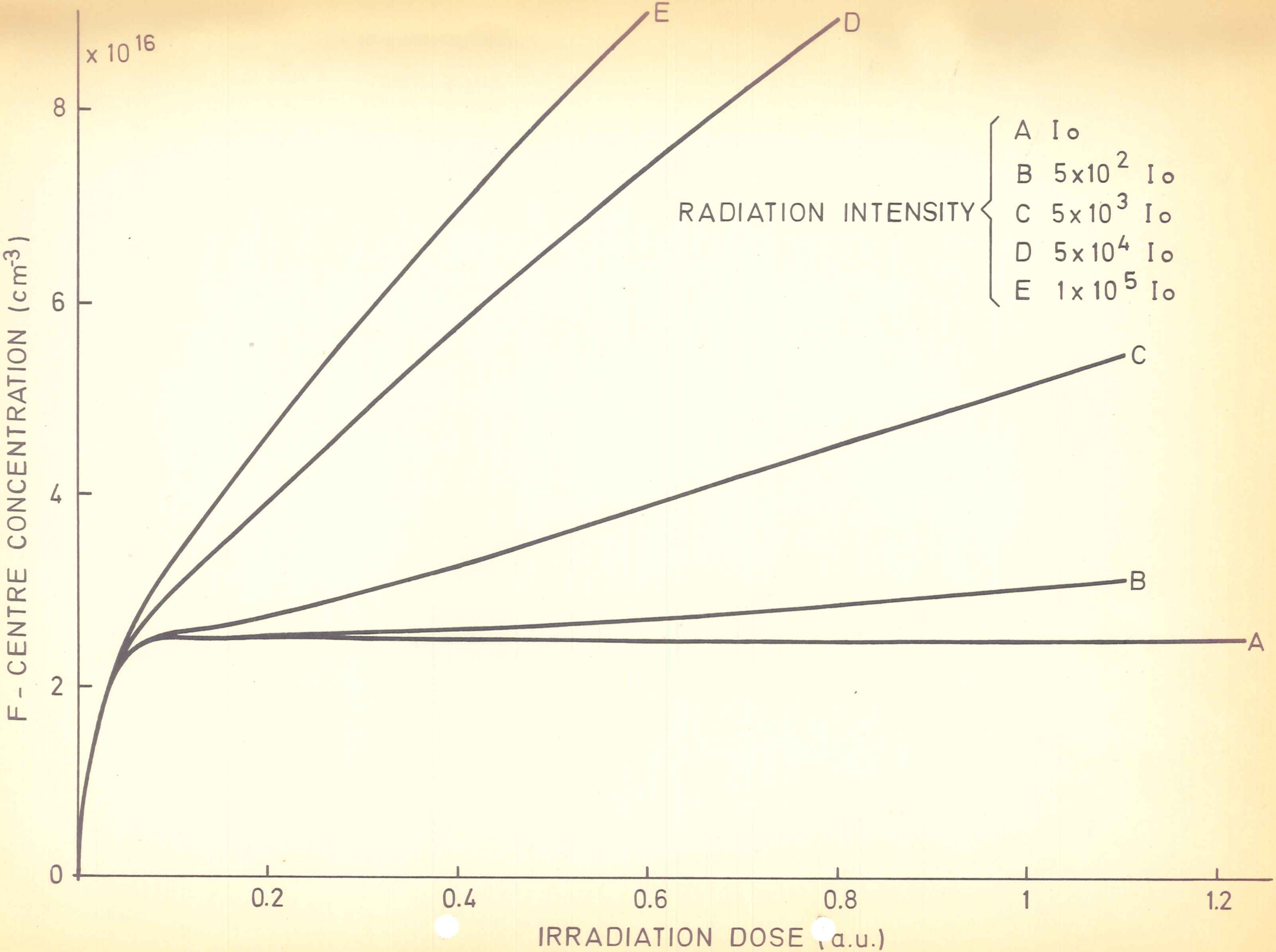
1- F. Agulló-López and F. Jaque, to appear in J.Phys.Chem.Solids

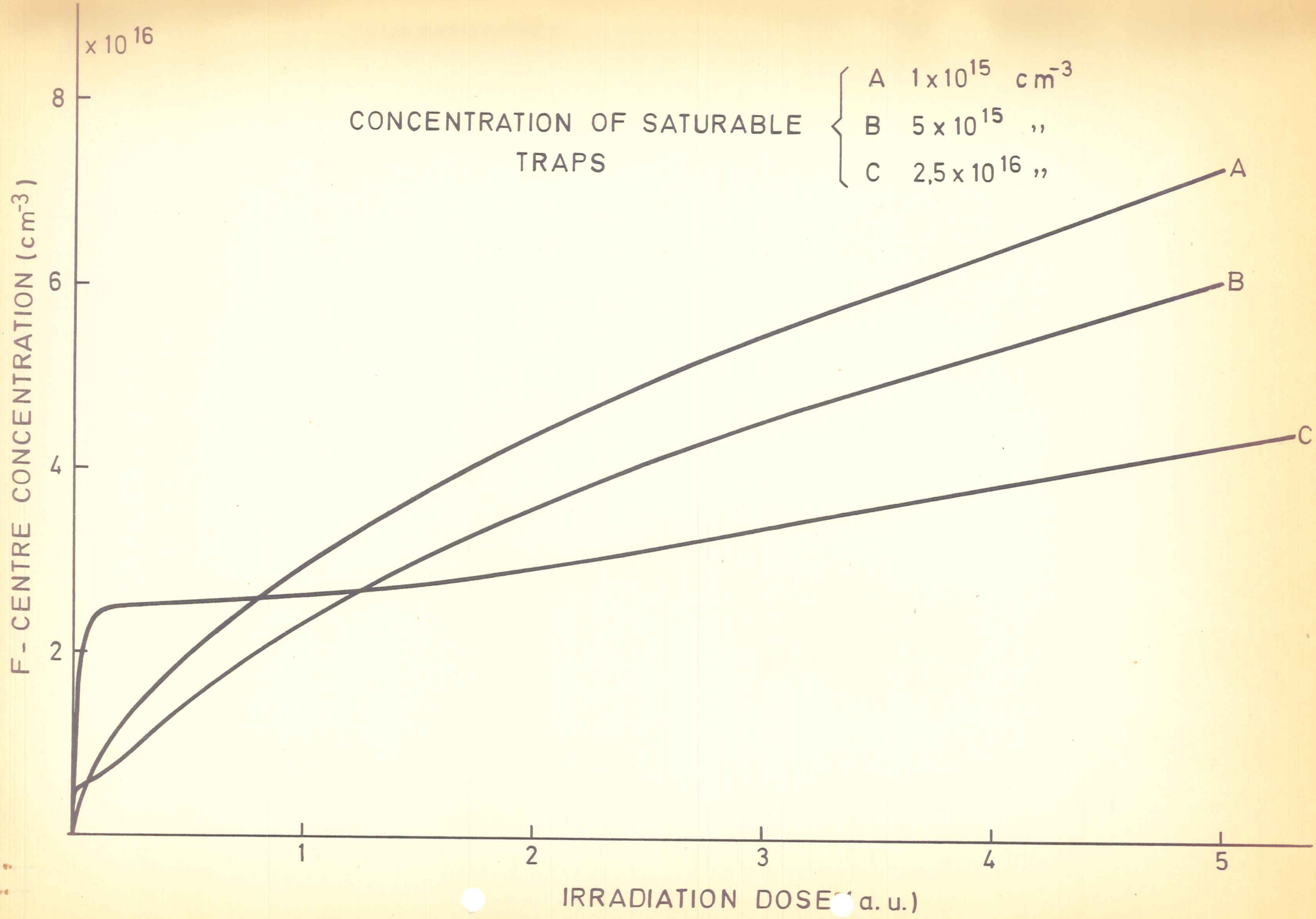
2- Y. Farge, J.Phys.Chem.Solids, 30, 1375 (1969)

3- P. Duramd, Y. Farge, and M. Lambert, J.Phys.Chem.Solids, 30 1353 (1969)



x 10 16
8
6
4
2
0
F - CENTRE CONCENTRATION (cm-3)
0.2
0.4
0.6
0.8
1
1.2
IRRADIATION DOSE (a.u.)
RADIATION INTENSITY
A Io
B 5x10 2 Io
C 5x10 3 Io
D 5x10 4 Io
E 1x10 5 Io
A
B
C
D
E

Fig (1)



x 10 16
8
6
4
2
F - CENTRE CONCENTRATION (cm-3)
CONCENTRATION OF SATURABLE TRAPS
A 1 x 10 15 cm-3
B 5 x 10 15 ,,
C 2,5 x 10 16 ,,
A
B
C
1
2
3
4
5
IRRADIATION DOSE (a. u.)

Fig (2)