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THICKNESS DEPENDENCE OF CATHODOLUMINESCENCE IN THIN FILMS

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Abstract. - Thin film samples have been increasingly used in high resolution imaging studies of cathodoluminescence (CL) from materials, in order to achieve the smallest CL source possible[1-3]. The analysis of the luminescence signals from thin film material is often hampered by the changes associated with the film thickness variation. This thickness effect has been analysed in a simple model which takes into account the diffusion of the excited states in thin films. The electron beam is assumed to provide a uniform excitation density over the entire film thickness appropriate to electron transparent films (the definition of which is also given). The intensity variation of CL signal as a function the foil thickness t is given by the formula $I(t) = I_0(t - \frac{2L}{\coth \frac{t}{2L} + f})$

where L is the diffusion length of the energy carrier in a bulk sample; f is the ratio of the bulk diffusion 'velocity' L/τ to that of the surface diffusion velocity s . Both physical parameters can be obtained from a plot of the CL intensity verses the film thickness. This has been applied to a number of materials such as $Y_2O_3:Eu^{3+}$, $YAG:Ce^{3+}$, Diamond and InP. For the last two types of materials, the result of the analysis is consistent with those from other experiments[3,4]. For phosphors with a relatively large doping of luminescent ions, the saturation effect caused by an intense excitation density must be taken into account in interpreting the physical parameters deduced[5,6].

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