Hyperbolic Phosphorescence Decay Kinetics: Empirical Formula and Theoretical Models

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The phosphorescence glow decay kinetics in solids was studied in a significant number of materials under the different types of excitation. It gets especial interest in last decades with growing interest to phosphors with so called persistent luminescence (PersL) and their application in many fields. It was found even in the middle of the 19th century, that the afterglow decay kinetics of many of irradiated phosphors is well described by the empirical Becquerel decay function $I(t)=I_0 (1+ct)^{-d}$, where parameter c and d can be found from the approximation of experimental dependence. The integral glow intensity $\int_0^\infty I(t)dt$ of the afterglow light corresponds to the net amount of stored energy (or dose of irradiation) in storage phosphor. But sometimes the power d becomes less than one and the Becquerel decay function becomes non-integrable which means formally that the light sum of phosphorescence becomes infinite that, of course, has no physical meaning.

It is exactly the case of YAP:Mn crystal being studied as storage phosphor for luminescence dosimetry by means of optically stimulated luminescence [1] as well as some other phosphors studied before [2].

Several approaches are known to explain the hyperbola-like kinetics with $d < 1$ [2-5], but till now there is no general understanding of this phenomenon.

The present work is devoted to analysis of theoretical models of processes occurring during the phosphorescence and to searching of their consistency with observed kinetics described empirically by non-integrable Becquerel function.

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