Effect of Catalyst on Lucigenin Chemiluminescence with Hydrogen Peroxide

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Abstract

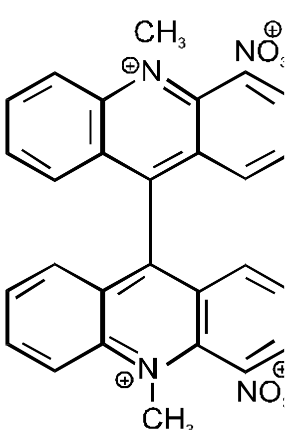
Chemiluminescence is the production of light during an exothermic chemical reaction.Certain chemicals emit their energy in the form of light, e.g. luminol lophine, lucigenin, lucigenin chemiluminescence takes place by the oxidation of lucigenin by hydrogen peroxide in the presence of a catalyst in alkali medium. The catalyst may be a compound having a transition metal like copper, iron, chromium, etc. The present paper reports the effect of the transition metal ions used as the catalyst in lucigenin chemiluminescence.

Key words: Chemiluminescence,lucigenin,catalysts

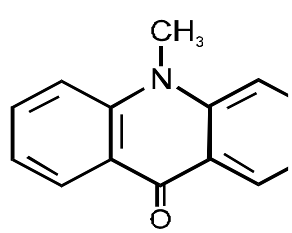
Introduction

Only a few years after the first paper on luminol, Glue and Petsch (1935) published the first report on lucigenin (a) chemiluminescence. It was eventually shown that the emitting species (N-methyl acridone (b) provided that at the appropriately low concentration, no energy transfer to secondary reaction products, formed from N-Methylacridone (b) in the aqueous alkaline medium takes place N-Methyl acridone fluoresces at 445 nm that is in the blue region of the spectrum that greenish chemiluminescence is generally observed is due to energy transfer from N-Methyl acridine (lucigenin), to dimethyl biacridylene and other compounds [1-2].

(a)



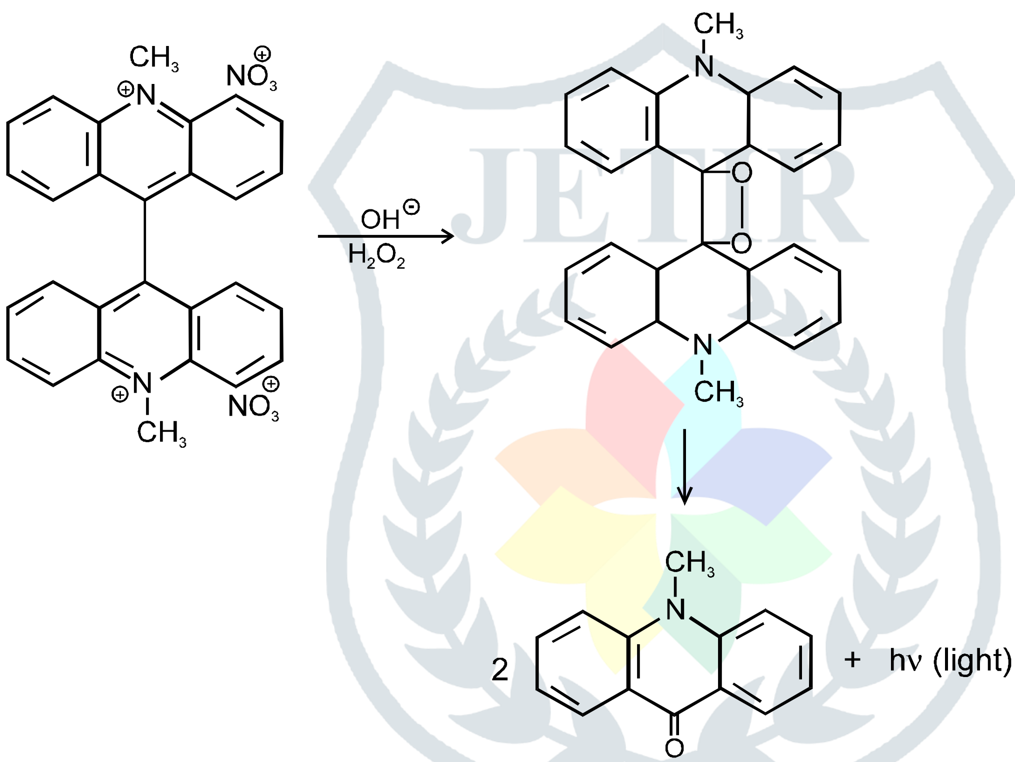
(b)



N-Methyl acridone is considerably more fluorescent than 3 Aminopthalate, the emitting species in the luminol reaction and so are numerous other acridine derivatives. Therefore, many efforts have been made to take advantage of the chemiluminescence of lucigenin and acridine derivatives especially for analytical purposes

Lucigenin chemiluminescence is the production of light by chemical reaction when N Methyl acridine in alkaline medium reacts with H_2O_2 in presence of a transition metal ion as a catalyst, intense luminescence is produced called Lucigenin chemiluminescence,

When lucigenin reacts with 5% H_2O_2 solution is presence of a Catalyst $CuSO_4.5H_20$ in alkali medium it oxidizes and energy is liberated in the form of blue coloured light emission called lucigenin chemiluminescence,



Experiment

A sample chamber consists of a metallic box, whereby in the lid of the box a hole is made to insert the test tube. An RCA 931A photomultiplier tube (PMT) is placed near the sample holder. One end of PMT is connected to X-Y recorder and the another end is connected to high voltage power supply (HVPS) (750 V). The complete set up of PMT box is covered by a black cloth with a hole to insert the syringe through which the oxidant hydrogen peroxide solution can be injected. I ml of lucigenin solution containing a catalyst in alkali medium was taken in a test tube and placed near Photomultiplier tube, then H_2O_2 was poured with the help of a syringe and graphs was plotted between intensity and time. The speed of paper fixed on X-Y recorder is kept constant through out the experiment to analyze the change in catalytic behaviour

Results

Fig. I shows the effect of catalyst lucigenin chemiluminescence. The maximum intensity can be observed in of $CuSO_4.5H_20$ and the minimum intensity is obtained when $CrCl_3$ is used as catalyst. $K_3Fe(CN)_6$, also acts as a catalyst but produces less intense light than $CuSO_4.5H_20$ but more than $CrCl_3$, which proves $CuSO_4.5H_20$ to be the best catalyst for the lucigenin chemiluminescence reaction.

Fig. 2 shows the graph of log 1 Vs (t_2-t_1) comparing the decay time of the catalytic activities of various catalysts. The decay time of the reactions show that $CuSO_4.5H_20$ has the maximum intensity and decay time is also longer whereas light produced by $K_3Fe(CN)_6$. and $CrCl_3$ are less intense and decay time is shorter

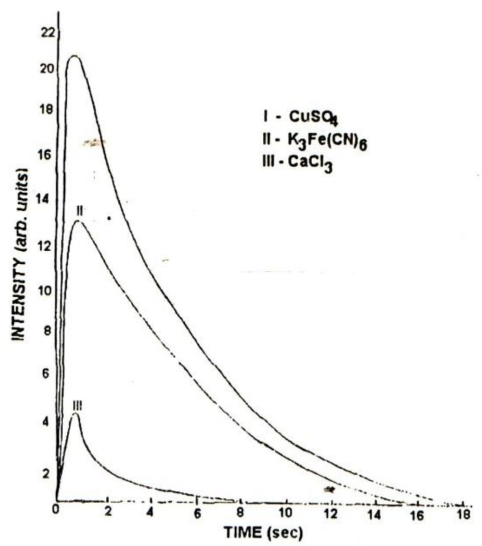


Fig. 1 : Dependence of time on chemiluminescence intensity for different catalysts

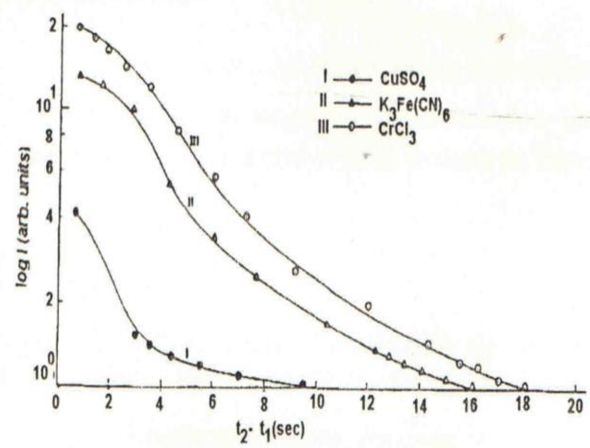


Fig. 2 : Plot of log I vs (t_2 – t_1) of lucigenin chemiluminescence for various catalysts.

Table 1 shows the time dependence of catalyst, the Imax of different catalyst showing that $CuSO_4.5H_2O$ has the highest intense light and peak of intensity is lower in $K_3Fe(CN)_6$ and $CrCl_3$;shows the lowest value of Imax. On comparing the decay time value, CuSO4.5H20 shows the longest decay time.

Table 1

I_{max} value of different catalysts in lucigenin chemiluminescence

Catalyst	□1 value (s)	□2 value (s)	I_{max} value (s)
$CuSO_4.5H_2O$	21.6	0.56	20
$K_3Fe(CN)_6$	13.4	0.46	12.1
$CrCl_3$	4.2	0.02	4.1

Discussion

As mentioned, catalyst are necessary for lucigenin chemiluminescence in aqueous media [3]. lt plays an important role to complete the reaction to produce intense light in alkali medium. When to solution of lucigenin, H_2O_2, is added in presence of $CuSO_4.5H_2O$as a catalyst, the intensity of the emitted chemiluminescence is maximum. This phenomenon was probably caused by the successive formation of Catalytically active forms of copper complexes differing in their correlation spheres, when $K_3Fe(CN)_6$ and $CrCl_3$ is used otherwise the same reaction coordinate occurs, there is only a simple increase in the intensity. Any transition metal compound can be used as a catalyst for this reaction, but the intensity of light produced differs based on the transition metal ion used in the catalyst. Catalyst plays an important role in the lucigenin chemiluminescence reactions. Any transition metal compound, when added in alkali medium to lucigenin solution, it affects the intensity of the light produced. Taking 0.2 g/l of lucigenin in solution and by using the different catalyst, i.e., Copper sulfate pentahydrate, potassium ferrocyanides andchromiunm chloride. By varying the catalysts, the comparative study of the effect of catalyst was made.

lt was concluded that the among the transition metal compounds, which were used as catalysts in lucigenin chemiluminescence, Cu in $CusO_4.SH_20$ is the best transition metal used as catalyst which produces the intense light of maximum intensity of all the catalysts used (5]

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