Methods of improving the performance of Lyoluminescence (LL) phosphors .

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Abstract

The paper reports LL measurements for which the dissolution process has been improved in order to limit the uncertainties and reaching lower limits of doses .

Materials ,such as NaCl and glucose($C_{12}H_{22}O_{11}$) have been tested with water and sensitized solutions , heated and kept at constant temperature during the read-out process.

When nitrogen gas is bubbled through the solution , the sensitivity of the material will be reduced for sensitized solution .for pure water the sensitivity of the material will be increased .and lower doses should be reached (minimum detectable dose :30 mGy) .

The reproducibility of the measurements will be increased for both sensitized and unsensitized solutions ,but it is clearly in sensitized solution .

1-Introduction

Lyoluminescence dosimetry (LLD),which involves measurements of the light emitted when a previously irradiated materials (phosphors) is dissolved in a solvent . It seams to have applications in the field of radiation production , one advantage being that LL materials are tissue equivalent (TE)[1].

The sensitivity of these materials depends on the physical characteristics of the material ,on the conditions of irradiation and on the condition of measurement .

Many efforts were done to improve the performance of this technique [1]. The use of sensitizers largely improve , the performance of various materials. Most of these sensitizers were chemiluminescences (CL) dyes [2]. The background of such dyes was largely due to the self glow that these dyes process .

One of excellent solutions of this problem was the incorporating phosphors [3] .Preparing dyes incorporated with TE materials phosphors needs ultrasonic shocking wave ,evacuated systems for preseptating the dissolved materials and other instrumentations that not available in some labs . And needs also some chemical experience because , there is no general procedure for preparing these incorporated phosphors . After several trials one can make a

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proper procedure . Of course this will demand more amount of the chemical materials.

This paper introduce another method to improve the performance of LL phosphors , By bubbling nitrogen gases during the process of phosphor dissolution .

2- Experimental

Solution of luminal (CL dye),(100 mg per liter), in bidistilled water was used as a solvent . the amplification of the solvent depende on the dissolved oxygen and on the PH of the solution [4].

Therefore 1.25 mg of haemine ,(CL – dissobutyi- cresoxy –ethoxyethyl - di-methylbenzyl ammonium hydroxide), were added to the solution for its PH within 10.5 and 11.5 .

The dosimetric tests have been carried out on glucose and on sodium chloride , since they are easily available .

The above materials were irradiated under electronic equilibrium conditions with Cs^{137} gamma ray source to the considered dose . Before each measurement (putting the irradiated phosphor in the solvent), the dissolution vessel filled 10 ml of water in the case ofNaCl and the same amount of sensitized solution for glucose . then nitrogen gas over pressure is bubbled through the solvent (in dissolution vessel) , by tube immersed in the solvent .

The LL signal is measured , instantaneously with the dissolution of the phosphor . During the measuring time ,15 second ,about 97% of the total light emitted by the sample is recorded . the sensitivity of the LL system is checked regularly with C^{12} light source .

3-Result and discussion

The dose response curve for glucose and NaCl dissolved also solution (of concentration 10^{-3} mole/liter) and water respectively , is shown in Fig (1). It is clear that glucose is rather sensitive than NaCl .

This is because of the high quantum efficiency of luminal [4] .The linear dose range extended frome 50 mGy to 4 Gy for glucose and from 0.1 to 50 Gy for NaCl .

When nitrogen gas bubbled through the solvent during dissolution process the dose response as shown in Fig (2).the effect of nitrogen was enhancing LL signal of NaCl and quenched the light yield of glucose .

This because nitrogen limits the effect of oxygen in the solvent [5]. on the other hand extra oxygen in pure water will masks LL signal from NaCl .

When the solution is saturated with nitrogen gas , LL signal will be reduced to (1/4) from its original value . so ,certain concentration of nitrogen dissolved in pure water will equate the excess of oxygen that quenched LL signal . on the

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other hand for sensitized solution the excess oxygen will increase the autoluminescence of the solution .

The LL signal is faster than Cl signal , so it is difficult to resolve one signal from the other , then the reduction in Cl signal will be occurred for LL signal too .

On dissolving Er^{13} ions the concentration 2g/liter in the solution the sensitivity of measurements will be increased.

This effect can be referred to the intermolecular energy transfer phenomena[6] .

The dose response curve for NaCl is shown in Fig (2) .The lowest dose can be reached is 30 mGy .

The reproducibility of the measurements was calculated by : for each sample yield was measured in times (usually 5) so that mean yield y , and standard deviation 6 , could be calculated . the reproducibility (precision) of readings ,(6 $_1$*100)y ,was usually 80% and 73% for glucose and NaCl respectively . After bubeling nitrogen in the solution the reproducibility become 92% and 96% , for doses of order 90 mGy.

4-conculation

Improvement of the performance of LL technique is one of the problems that take major care of the workers in this field .

Many trials were done , and results of different importance were gained , For detail see references 1 to 6 . But the performance method faced with complications and phosphor preparing .

The method discussed in this paper seems to be easier than those mentioned in references 1 to 6 . it does not need special arrangement for the measurements and also no special preparing of the phosphors .

For example a comparison between the results of this work and the other work, in references 1.2 and 4 the lowest detectable dose were 3Gy , .6 Gy and 0.3 Gy , with standard error deviation of 8%, 24%and 15%respectively .While the results obtained in this work

are ,30mGy for NaCl and 25 mGy for glucose ,with standard error deviation 10% and 5% respectively .

Finally one can suggest that cooling f the photomultiplier tube and butter light collection ,were another step for improveing illuminometer performance as a future works.

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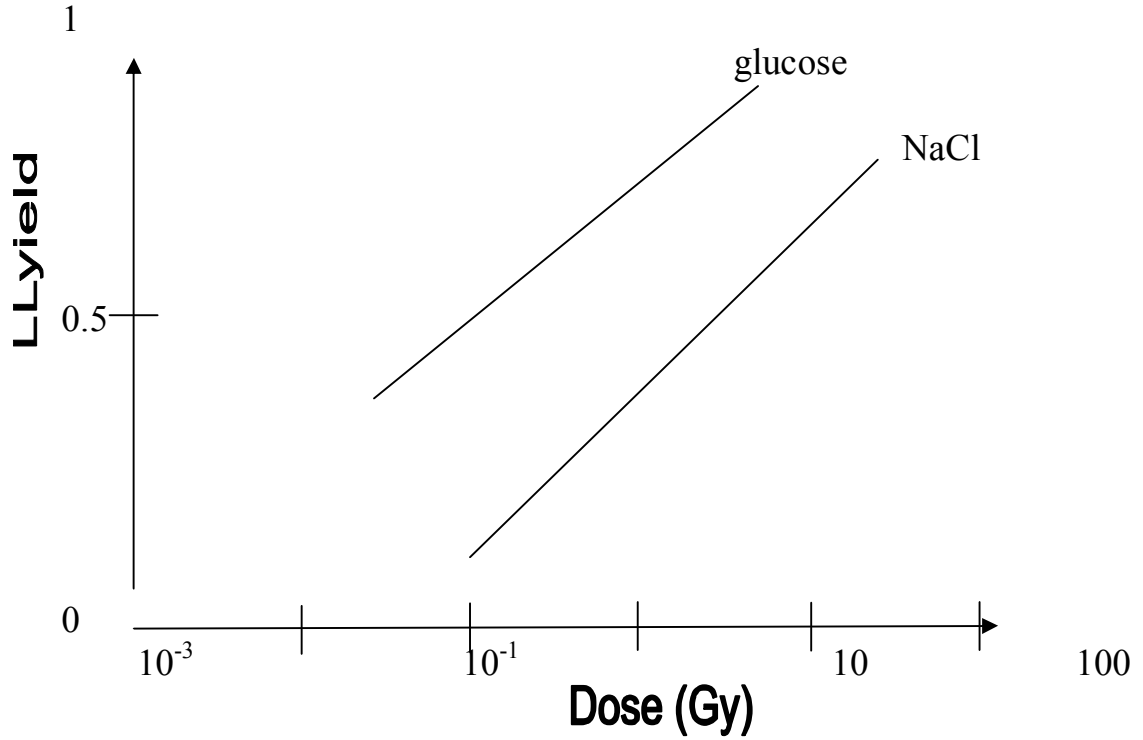

Fig .(1) : dose response curve for NaCl and glucose irradiated at room temperature . Before using nitrogen .

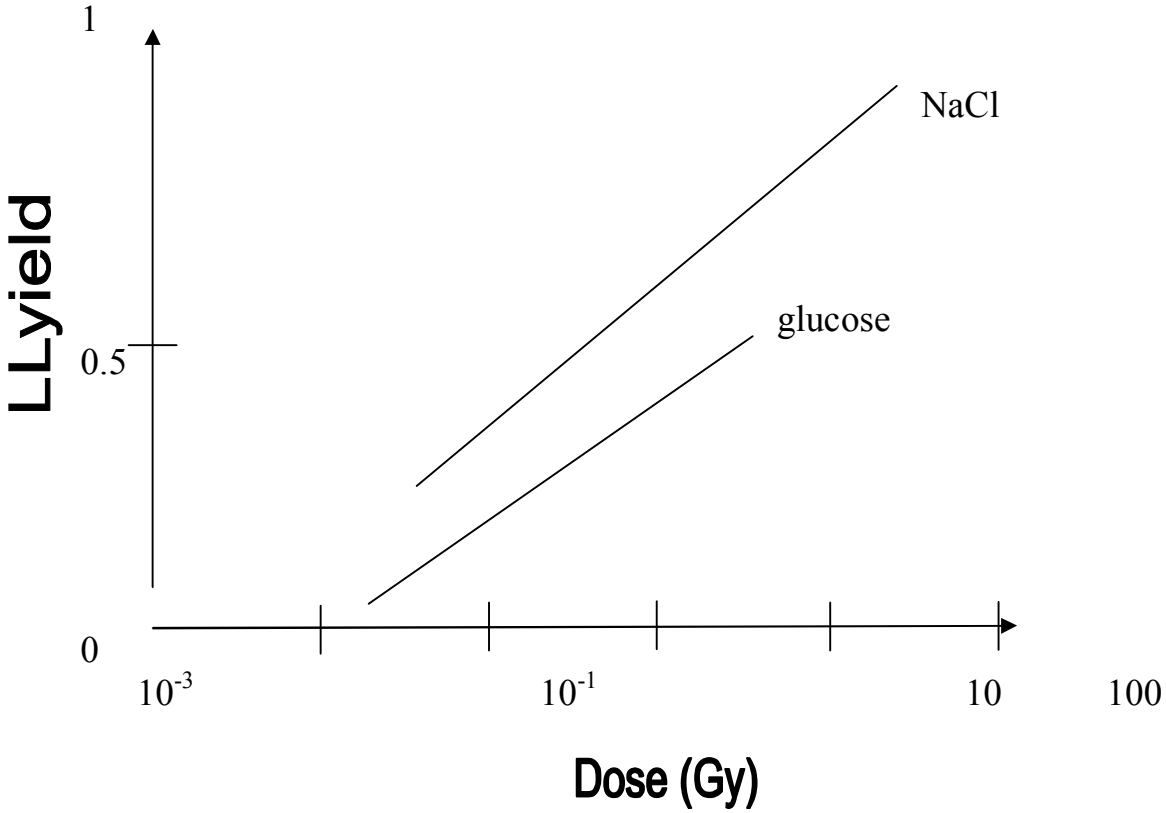

Fig .(1) : dose response curve for NaCl and glucose irradiated at room temperature . The LL yield was measured through bubbling of nitrogen in the solution

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الخلاصة

في هذا البحث تم أستخدام طريقة التألق الأذابي لتحسين مديات القياس الغير دقيقة وصولاً إلى الجرع الواطئة نسبيا .

تم أختيار مادة كلوريد الصوديوم والكلوكوز مع الماء وبعض السوائل الحساسة ، درجة الحرارة تم تثبيتها خلال عملية الفصل .

عندما فقع غاز النتروجين في المحلول حساسية المواد المستخدمة قد قلت وأصبح المحلول ذات حساسية قليلة .

بالنسبة للماء النقي حساسية المادة ازدادت وأقل جرعة ممكن الوصول لها (أوطأ درجة كشف) كانت (30 mGy) .

القياسات المستحصلة كانت قد ازدادت لكل من المحاليل الحساسة وغير الحساسة التي تحت الدرس ولكن أصبحت أكثر وضوحاً في المحاليل الحساسة .

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