

1

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COMPRESSED LITHIUM FLUORIDE DOSIMETER PELLET

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ABSTRACT OF THE DISCLOSURE

A dosimeter consisting of a pellet of LiF compressed in a binder of sodium silicate, and the method of preparing such pellet including compressing the mixture to above 18,000 p.s.i.

BACKGROUND OF THE INVENTION

One radiation dose recording principle is based on the ability of some materials to absorb and retain an amount of energy proportional to a radiation dose. Upon heating, these materials re-emit this energy in the form of light which can be measured with available instruments. These materials are called thermoluminescent materials.

A preferred dosimetric material is lithium fluoride, having impurities of about 10 to 100 parts per million magnesium, on the order of .01% calcium and traces of aluminum, iron, titanium and silicon. Such material is readily available commercially. Hereinafter the term "dosimetric lithium fluoride" shall be used to denote lithium fluoride having induced crystal imperfections to enhance its thermoluminescence and improve the linearity of the radiation dose dependence in the dose range 0-10⁵ R. of gamma radiation.

One of the current techniques in use for preparing dosimeter lithium fluoride for its dosimeter application is to mix the powdered material in a binder matrix such as Teflon and form the resulting mixture into discs. It has been found that discs prepared with Teflon are not able to measure accurately dosages less than 50 mR. and that annealing temperatures are limited to about 300° C., although other researchers have discovered that best results with LiF are obtained when an annealing temperature of 400° C. is applied.

Another approach to the problem of using LiF effectively is that shown in U.S. Patent No. 3,243,590 in which a binder of potassium silicate is used and the dosimeter mixture is clamped between mica sheets to prevent the mixture from brushing off. However, the use of potassium silicate and that of a cover sheet or plate limits somewhat the sensitivity of the mixture at low radiation levels. Potassium usually contains some of its isotope K⁴⁰ which is undesirable in the low dose range as the dosimeter background radiation will be added to the radiation being measured. In addition, the patented arrangement describes a filtering and sticking operation in preparing the dosimetric sample which limits the concentration of the LiF and adds a further limitation of sensitivity at low dosage levels.

DESCRIPTION OF THE INVENTION

The present invention makes it possible to use LiF as a dosimetric material at lower radiation levels and higher temperature than heretofore was thought to be possible. Radiation levels at dosages down to about 10 mR. can be reliably monitored and an annealing temperature of 400° C. can be reached in the dosimetric material which gives best reproducible results.

These advantages are accomplished by the present invention by using sodium silicate as the binding matrix

2

and a pressing operation which makes it possible to eliminate the use of a cover sheet and to obtain a higher concentration of the LiF.

It is thus a principal object of this invention to provide an improved dosimetric material and method of preparing same for the detection and measurement of radiation.

Other objects and advantages of this invention will hereinafter become more apparent from the following description of a preferred embodiment of this invention.

In a preferred embodiment of this invention, a pellet of LiF is prepared from dosimetric LiF powder which is compressed in the presence of a sodium silicate water solution by a die and plunger. The result of this process is to produce a pellet which is highly sensitive to radiation down to about 10 mR. and does not require the use of a cover sheet to hold the material together.

Example

Samples of about 50 mg. each of LiF were mixed with from about 8 to 20 mg. of sodium silicate water solution. The density of the starting LiF powder was in the range of 1.3 to 1.5 gms./cm.³ which passed a sieve, Tyler equivalent mesh 100 and is retained on a sieve, Tyler equivalent mesh 200, as is understood in the art. For each sample, the mixture was poured into a 0.313" diameter cavity in a die, and a plunger in the die pressed down on the mixture by the use of a press at a force of 9000 lbs. The die and plunger were designed to leave a 0.017" deep space available for the formation of the pellet. The pressures on the powders were estimated to be 18,000 to 23,000 p.s.i. The pellets produced were then removed and placed in a furnace and heated one hour at 400° C., cooled rapidly at ambient temperature by placing on a metal strip, and then heated at 80° C. for 20 to 24 hours. After this the pellets were placed on a flat strip of plastic tape and exposed to X-radiation. The pellets were read out using a commercial reader. No cover sheets were required or used to hold the material together even though the pellets were quite thin, less than 0.025". The light responses were found to be linear and it is believed that the linearity, if tested, would have extended down to about 10 mR.

The pellets prepared in accordance with this invention had a density of 2.2 gms./cm.³ as compared to that of solid LiF of about 2.64 gms./cm.³ and were found to be useful for the measurement of X-rays in the range of 15 to 9500 mR. and did not require cover sheets or other provision to hold the material in the pellet together. This increased sensitivity to radiation is believed to result from the higher density of LiF obtainable in a thin pellet with the use of compression to form the pellets and the use of the best technique for annealing which requires heating to 400° C.

While only preferred embodiments of the invention have been described, it is understood that the invention is to be limited only by the scope of the appended claims.

What is claimed is:

1. A thermoluminescent dosimeter having improved sensitivity, linearity, and effectiveness comprising a compressed pellet of dosimetric LiF powder mixed with a binder of sodium silicate, said pellet having a density of about 2.2 gms./cm.³.

2. The dosimeter of claim 1 in which the pellet is less than 0.025" in thickness.

3. A method of preparing a thermoluminescent dosimeter comprising the steps of:

- (a) mixing dosimetric LiF powder with a solution of sodium silicate;
- (b) compressing the mixture at a pressure in the range of 18,000 to 23,000 p.s.i. to form a pellet;
- (c) heating the pellet up to about 400° C.;

3,402,293

3

- (d) cooling the pellet rapidly at ambient conditions;
and
(e) heating said pellet at 80° C. for the period 20 to 24 hours.

4. The method of claim 3 in which the pellet is compressed to a density of about 2.2 gms./cm.³ and a thickness of less than .025".

4

References Cited

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