

1

2,830,969

ELECTRON PENETRATION MEASUREMENT

Charles M. Zoubek, Oak Lawn, Ill., assignor to Swift & Company, Chicago, Ill., a corporation of Illinois

No Drawing. Application March 7, 1951
Serial No. 214,425

6 Claims. (Cl. 250—49.5)

The present invention relates to materials and processes for determining the depth of penetration of electrons in substances.

It has long been recognized that for many applications electron irradiation (usually by electrons brought outside an acceleration tube through a window) has a number of advantages over other more commonly used forms of irradiation, as, for example, X-rays. One factor to which these advantages are attributable is that the electron gives up the major portion of its energy near the end of its travel.

The advent of new methods and apparatus for achieving higher energy electrons, resulting in the ability to obtain greater depths of penetration in the irradiated substances, has spurred additional experimentation toward the development of applications, commercial and otherwise, of electron irradiation. For example, work has been done in the use of electrons in the sterilization of food products and the treatment of deep-seated cancers.

In much of this experimentation, as well as in applications resulting therefrom, it is necessary or desirable that the operator know the depth of penetration that is to be expected as a result of the projecting of electrons from a given device into a particular substance. In many instances, one or more of the conditions of the irradiation will be subject to change, requiring constant checking to make sure that the electrons are expending the major portion of their energy at the desired depth in the product. The principal object of the present invention is to enable a worker to quickly and easily ascertain what the depth of penetration will be with the conditions present at a given time.

An important feature of the invention is that the determination is simply performed and the desired information is immediately available. There is no necessity for performing additional time-consuming operations such as the development of photographic plates or the like.

The specific form of the electron generator is of no significance with respect to the present invention. A number of such devices are well known in the art, as, for example: United States Patent No. 2,429,217 and Journal of the Franklin Institute, vol. 202, page 693 et seq. As is well known, the effective range of electrons from such a generator may be varied in a number of ways; for example, by changing the distance from the end of the tube, by changing the accelerating voltage, or by interposing shields of varying thickness.

In the preferred embodiment of my invention, an electron-sensitive indicator, triphenyltetrazolium chloride, is mixed in a readily-sliced solid, a jelly of water and gelatin, having at least one plane face. The solid is irradiated with electrons after placing said plane face normal to the path of travel of the electrons. After irradiation, the jelly is sliced parallel to the path of travel of the electrons therein and the depth of the indicator coloration therein is measured. With triphenyltetrazolium chloride, the coloration is purple.

2

The jelly may be previously made up in standard quantities, the density of which is known for use as herein-after discussed. Small receptacles such as paper cups or the like, filled with the standard jelly, may be kept on hand at all times for use as the need arises.

If unknown, the density is ascertained for the material for which the depth of penetration is sought, and as soon as the depth of penetration in the irradiated jelly is ascertained by measurement, the depth of penetration in said material to be expected of the same energy electrons is computed from the formula

$$l = \frac{Ld}{D}$$

wherein:

l —depth of penetration to be determined for said material to be irradiated

L —measured depth in said jelly

d —density of said material

D —density of said jelly

Suitable tables or other well known aids may be used to expedite the making of the foregoing calculation. Obviously, the use of a standard jelly will be an aid, particularly where the necessity for making the depth determination occurs frequently.

In some instances, it may be feasible and desirable to mix the electron indicator with the material within which the depth of penetration is sought. The resultant mixture is then irradiated, and, after slicing, the depth of penetration is obtained directly, without involving any computation. In eliminating the computation step involved in the use of the foregoing formula, care must be taken to be sure that the density of the mixture does not differ substantially from the density of said material.

The step of slicing the test mixture is important because the sides of the mixture may be affected by stray electrons to give color changes not indicative of the penetration of the electrons from the face of the material nearest the end of the electron emitter. Therefore, it will be apparent that, normally, the test mixture should be a solid.

The step of slicing may be eliminated if care is taken to insure that the electrons only enter the test material from one face of the material. One way in which this may be done is to protect the other faces of the material by placing the material in a shield through which the stray electrons will not penetrate.

The foregoing description of a specific embodiment is for the purpose of complying with 35 U. S. C. 112 and should not be construed as imposing unnecessary limitations upon the appended claims.

I claim:

1. The method of determining electron penetration in a given object from a given electron source, said method including the steps of producing a solid mixture by dispersing an electron-sensitive indicator in another material, irradiating said mixture with electrons from said source with the mixture so positioned that the path of said electrons from said source is normal to a face of said solid mixture, slicing said mixture parallel to said path, measuring the depth of existence of the indicator change from said face and computing the depth of penetration in the given object from the formula

$$l = \frac{Ld}{D}$$

wherein:

l —depth to be determined for said given object

L —measured depth in said other object

d —density of said given object

D —density of said other object

2. The method of determining electron penetration in a given object from a given source, which method includes the steps of producing a jell of gelatin with triphenyltetrazolium chloride therein, irradiating said jell with electrons from said source with the jell positioned so that the path of the electrons is normal to a face of the jell, slicing said jell parallel to said path, measuring the depth of existence of the color change in the jell from said face and computing the depth of penetration in the given object from the formula

$$l = \frac{Ld}{D}$$

wherein:

l =depth to be determined for said given object
 L =measured depth in said other object
 d =density of said given object
 D =density of said other object

3. The method of determining electron penetration in a given solid material, including the steps of producing a solid mixture by dispersing triphenyltetrazolium chloride in said material, irradiating said mixture with electrons traveling along a path normal to a face thereof, slicing said mixture parallel to said path, and measuring the depth of color change from said face.

4. The method of determining electron penetration in a given object from a given electron source, said method including the steps of producing a solid mixture by dispersing an electron-sensitive indicator in another material, irradiating said mixture with electrons from said source with the mixture so positioned that the path of said electrons from said source is normal to a face of said solid mixture, protecting the other faces of said solid mixture with shields, measuring the depth of existence of the indicator change from said face, and computing the depth of penetration in the given object from the formula

$$l = \frac{Ld}{D}$$

wherein:

l =depth to be determined for said given object
 L =measured depth in said other object
 d =density of said given object
 D =density of said other object

5. A method as in claim 4 wherein the electron-sensitive indicator is triphenyltetrazolium chloride.

6. The method of determining electron penetration in a given object from a given electron source, said method including the steps of producing a solid mixture by dispersing triphenyltetrazolium chloride in another material, irradiating said mixture with electrons from said source with the mixture so positioned that the path of said electrons from said source is normal to a face of said solid mixture, measuring the depth of existence of the indicator change from said face, and computing the depth of penetration in the given object from the formula

$$l = \frac{Ld}{D}$$

wherein:

l =depth to be determined for said given object
 L =measured depth in said other object
 d =density of said given object
 D =density of said other object.

References Cited in the file of this patent

- 30 "Problems Concerning the Production of Cathode-Ray Tube Screens," by H. W. Leverenz, J. O. S. A., vol. 27, January 1937, pp. 25, 26 and 27.
 "Electronized Chemicals," Fortune Magazine, March 1946, p. 108.
 35 Science, vol. 106, 1947, pp. 294, 295.
 "Radiation Effects On 2, 3, 5-triphenyltetrazolium Chloride Solutions," Gierlach et al., American Journal of Roentgenology, October 1949, pp. 559-563.
 "Science," vol. 113, June 1951, pp. 751-54.