THERMOLUMINESCENCE

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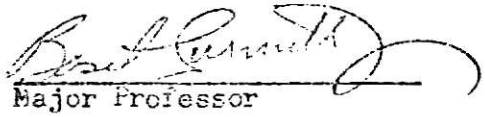

Major Professor

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GENERAL DISCUSSION

Luminescence is the phenomenon of emission of electromagnetic radiation in excess of thermal radiation. While the radiation is usually in the visible portion of the spectrum, the luminescence phenomenon can also give rise to infrared or ultraviolet radiation. Luminescence is regarded in general as a low-temperature phenomenon totally divorced from incandescence. Excitation of some luminescent substance is prerequisite to luminescent emission as would be expected in accordance with the principle of energy conservation. Some commonly experienced luminescent processes are photo-luminescence which depends upon electromagnetic excitation, cathodluminescence which depends upon excitation by energetic electrons or cathode rays, electroluminescence which depends upon an excitation voltage and tribo-luminescence which depends upon an excitation of a mechanical nature such as crushing, straining, or grinding. Finally one has as the topic of interest thermoluminescence which, with respect to the aforementioned luminescent processes, is a misnomer in that while the prefixes of the previously mentioned processes denote the means of excitation that prompts the emission such is not the case in thermoluminescent emission. The thermal energy supplied to a thermoluminescent substance serves merely to stimulate emission from the substance which has been excited by another means.

Luminescence phenomena can be divided into two categories: fluorescence and phosphorescence. Fluorescence is that radiation which persists only during excitation while phosphorescence refers to the exponential afterglow of a substance after excitation is removed. Thermoluminescence of course belongs to the latter category and among the many substances which exhibit

thermoluminescence are the inorganic solids helpfully called the phosphors.

Thermoluminescence was first reported by Boyle over 300 years ago, and in the early part of the present century it became a well recognized phenomena. Not unlike the Edison effect, thermoluminescence was initially regarded as a curiosity: but since, it has become an important and valuable research tool to the archeologist, geologist, medical technologist, and physicist. As thermoluminescence processes are more fully understood, surely more professions will profit through thermoluminescent techniques and applications.

One would naturally pose the question of what substances exhibit thermoluminescence. Very broadly it can be said practically any non-metallic crystaline or quasi crystaline substance, i.e., limestone, ice, bone, pottery, glass, as well as many other materials may exhibit thermoluminescence.(1)

There are four ways a substance can get rid of the energy absorbed during irradiation:

(a) All the energy may be used to increase the thermal motion of the atoms of the substance,

(b) Some of the energy may be used in photochemical reactions,

(c) Absorption of energy may result in the emission of photoelectrons,

(d) Absorption may give rise to luminescent emission.

Emission of luminescence then depends upon how effective a substance is in protecting the absorbed energy from loss in (a), (b), and (c) above. Unless the energy is absorbed and re-emitted at the same place in the material, there must be an efficient means by which the energy can be transported, without serious loss from its place of absorption to the place at which emission occurs. The latter locations are generally called luminescence centers. It is in these centers that electron transitions responsible for luminescence emission can take place with a minimum of