Luminescence Technique and Research on OSL Measurement Instrument

A.M. Peng[1], G.X. Wang[2], J.J. Kang[2], J. Yang[1]
[1] School of Geophysics and Information Technology and Key Laboratory of Geo-detection (China University of Geosciences, Beijing), Ministry of Education, Beijing 100083, China
[2]Shijiazhuang University of Economics (Shijiazhuang), China

Abstract: Thermally stimulated luminescence (TL) and optically stimulated luminescence (OSL) have been used in geological dating and radiation dose assessment after nuclear accidents. An OSL measurement instrument was developed and an apparatus for automatism carry sample and stimulation source was developed later. Recently an improved design based on pseudo random theory presented for the instrument. An advantage of this design is to avoid possible pulses loss caused by count carry for high radiation sample and to gain more accurate radiation dose.

Keywords: OSL; Technique; Instrument

1. Introduction

The radiation energy is stored in the form of electrons in the crystal lattice of mineral such as quartz and feldspar which have been previously exposed to ionizing radiation. While stimulated, the trapped electrons are quickly released. Some electrons then give rise to radiative recombinations with trapped "holes", resulting in emission of light. According to the methods of stimulation, thermal or optical, there are thermal stimulated luminescence (usually called thermoluminescence, TL) and optical stimulated luminescence (OSL).

Luminescence signal was first observed by Robert Boyle(1663). But people began to study and use luminescence techniques until the end of World War Ⅱ. With the development of solid physics and nuclear technology, especially the applications of the photomultiplier tubes as a sufficiently sensitivity of the photon detector, luminescence techniques gradually developed. Luminescence techniques have been used in archaeological dating, geological dating, oceanography, space science, quaternary research *et al.*

2. OSL System

Since OSL was introduced by Huntley *et al*. (1985), many techniques and methods have been studied and introduced.

Samples such as quartz and feldspar can be extracted from bricks, tiles or pottery collected in nuclear accident areas. When the sample is stimulated, it releases the energy in the form of light photons. Photons captured by photomultiplier (PM) tubes, and the optical signals are converted to electric signals. The electric signals sent to a pre-

amplifier, analog to digital converter, then feed to a pulse counting circuit. The counts accumulated during measurement can be converted into light intensity and get a dose of radiation.

An OSL measurement system consists as follows: excitation light source, PMT system, data acquisition system. A structure diagram of an OSL instrument is shown in Fig.1.

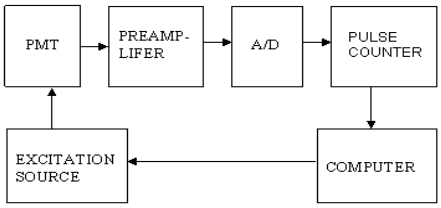

Fig.1 Structure diagram of instrument

The improvement work which has been done for OSL system will be introduced in the following section.

3. Development of Instrument

Both semiconductor laser light source and automatic sample changing apparatu have been developed (Kang and Wang et al.). The laser source is PC-controlled without preheating and output power of laser is adjustable. With the sample changing apparatu, 20 samples are changed in sequence during measuring.

An improve design for electronic measurement system of instrument is presented recently. Most pulse counters are realized by binary carry counter. Count carry may cause pulse signal loss in high counting rate.

It is important for measurement system to obtain accurate equivalent radiation dose When the sample is illuminated, light signal is observed to take a form of a luminescence decay curve, following an exponential- like function. The area under decay curve is used to determine the radiation doses. If signal pulses are heaped during measureing, chang of decay curve will reduce the peak area.

State counter based on pseudo-random maximal-length sequence is designed instead of carry counter in measurement system. In order to obtaining more available state, feedback logical circuit added. To ensure the circuit in working, inclusive-or operation is changed into exclusive-or operation, the state **0** be used as the stop count state, so for a 32-bit state counter, available state is 2^{32}-1. But for a high bit state counter, the state table is huge so it needs to study a new program algorithm for software.

4. Discussion and Conclusion

Some improve work for OSL instrument has been discribed and a new design method for counting circuit is intruduced in details. The development of sensitive systems is required in the next step.

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