Thermoluminescence Analysys

IPSES

Ideazione Progettazione Sviluppo Elettronica Scienitifica

Conceiving, Planning and Development in Scientific Electronics

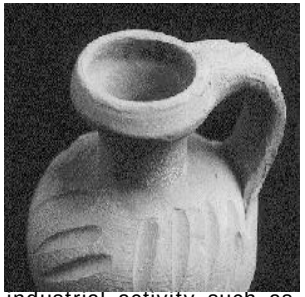
TL2000 Laboratory

Brief info about Thermoluminescence

What is thermoluminescence?

When a radiation is incident on a material, some of its energy may be absorbed and re-emitted as light of longer wavelength. The wavelength of the emitted light is characteristic of the luminescent substance and not of the incident radiation.

Thermoluminescence (TL) is the process in which a mineral emits light while it is being heated: it is a **stimulated emission** process occurring when the thermally excited emission of light follows the previous absorption of energy from radiation. Energy absorbed from ionising radiation (alpha, beta, gamma, cosmic rays) frees electrons to move through the crystal lattice and some are trapped at imperfections in the lattice. Subsequent heating of the crystal can release some of these trapped electrons with an **associated emission of light**. **If the heating rate is linear** and if we suppose the probability of a second trapping to be negligible with respect to the probability of a recombination, the TL intensity is related to the activation energy of the trap level by a known expression. It is so possible to determine the trap depth.



Application on Archaeological findings

Material and objects of archaeological or historical interest that can be dated by thermoluminescence analysis are ceramics, brick, hearths, fire pits, kiln and smelter walls, heat treated flint or other heat-processed materials, the residues of industrial activity such as slag, incidentally fire-cracked rocks, and even originally unfired materials such adobe and daub if they had been heated in an accidental fire.

Fundamental principles of dating technique

A non-negligible part of materials which ceramic is usually made of (like *quartz* and *feldspars*) is thermoluminescent: those materials have trap states that can capture electrons after interaction with alfa, beta and gamma rays existing in nature. When these materials are heated to several hundreds of Centigrade degrees, electrons are evicted from trap states and energy is emitted in form of light: thermoluminescence (TL) . Heating ceramic in a furnace resets TL accumulated by clay and other materials; from this time on, TL begins growing again as time passes; the more concentrated radioactivity where ceramic is, the quicker TL grows.

Thus by measuring TL we can date an object since the last time it was heated above 400°C. Since measured TL depends on time of exposition to natural radiations but also on the intensity of these radiations, to achieve a precise dating we need information about radioactivity of the area where the object was found.

The potential of **dating techniques** through thermoluminescence analysis in Archaeology is known and their reliability has been demonstrated: dating accuracy of 5-10% can be achieved in a range of 50 to 20.000 years is the sample is correctly picked up. This technique is a *destructive method* of inquiry, since it requires non-negligible sample quantities (at least 10 grams of ceramic and excavation terrain).

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Everything you need to build your Thermoluminescence Lab,
From design to installation, from testing to technical support.

With offices and laboratories close to Milan, **IPSES** operates in the lab instrumentation sector, designing customized electronic solutions, not only by producing and delivering scientific instrumentation, but also through efficient and qualified support, courses and lectures on the basics on principles and methods, and guiding our customers in choosing the right instrument and learning how to use it most efficiently.

In **IPSES** you can find quality, confidence and experienced personnel, a **unique contact** for a complete support service.

What you need to build a thermoluminescence lab

The instrumentation required for a thermoluminescence lab consists of:

- A **vacuum oven** to heat the sample
- A **thermoregulation unit** with enough precision to control the heating ramp
- A **photo-detector** (made up by signal acquisition stage, a sensitive photomultiplier and a high-voltage power supply for the photomultiplier) capable of acquiring the thermoluminescence signal from the sample at different temperatures
- A **radioactivity measurement unit** (alpha activity) to measure radioactivity in the terrain where the sample was found, by using **scintillators**
- A device capable of keeping an inert gas inside the vacuum oven
- A **dryer** and an **ultrasonic bath** to prepare the samples
- *Personal computer* and *software* to control analysis system
- Radioactivity sources to calibrate the instruments.

IPSES instrumentation for Thermoluminescence Analysis

Vacuum oven to heat samples. The oven is made up of an heating strip (up to 650°C) an insulated thermocouple, a pressure gauge ranging from -1 to 0 bar, connectors for Nitrogen in- and out-take type *DN16KF* and a diaphragm with IR filters, all vacuum tight.

TL2000 integrated thermoregulation unit. Designed to yield very precise and time-steady heating ramps, to heat samples in order to analyze **photoemission** at various temperatures.

Heating control is very precise, thanks to a PID feedback control. Moreover, the TL2000 automatically controls photon acquisition operated by the photomultiplier.

Calph: Alpha activity counting device. This device is provided with a double single-channel analyser with programmable threshold.

It also has an integrated high-voltage power supply that can be directly connected to the photomultiplier used in measurements.

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IPSES instrumentation for Thermoluminescence Analysis

Photo-detector system

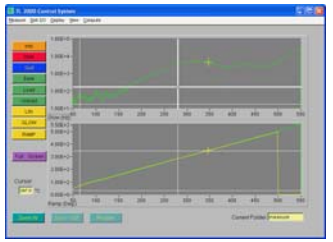
The system is made up by a 52mm **photomultiplier**, with peak sensitivity around 400nm, along with **housing**, **filters** and signal **pre-amplifier**. The system is guaranteed to deliver fast detection and high sensitivity needed in photonic detection.

HiVo adjustable high voltage power supply.

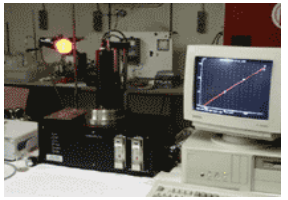
This instrument is designed to yield an adjustable output voltage in the range between 240V and 1,500V, in order to correctly power the photomultiplier.

HiVo is provided with a 3.5-characters LCD *display* showing output voltage. Voltage adjustment is carried through a multi-turn potentiometer with optimal precision and sensitivity.

Software for system control and management



Integrated measurement software for TL dating capable of controlling data acquisition, operating on acquired glow curves and managing a measures database. It runs on a PC with Windows '95 and above.



Our thermoluminescence laboratories are currently used in **Università degli Studi in Milan**, Istituto Nazionale di Fisica della Materia (INFM), **Università degli Studi in Lecce**, **Università degli Studi in Bari, Pastis CNRSM in Brindisi**, **Arcadia** Tecnologie per i Beni Culturali in Milan and **Department of conservation and restoration of the Museum of Xian** (China).

Accessories*

- **Instrumentation to prepare the samples:** dryer and ultrasonic bath to purge water from the samples
- **Rotational vacuum pump** and connectors, to take the air out of the oven
- **Scintillator disks ZnS on Mylar** to detect alpha activity in the terrain where the sample was found in
- ***Personal Computer*** with GPIB interface for connection with TL2000

* *The room used for the lab has to be equipped with a distribution system for Nitrogen. Moreover, it should be possible to completely darken the room, since analysis must be carried out in darkness. According to enduring laws, it is full responsibility of the user to undergo all security rules to run a laboratory and to obtain all the authorizations to keep and use radioactivity sources. The customer should take care of buying such sources. On request IPSES can help find authorized resellers for beta and gamma sources.*

Estimates and information

For information, estimates and technical support, please contact:

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