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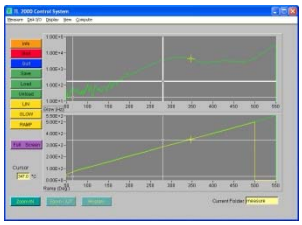
Scientific
Electronics



TL2000 Laboratory for Thermoluminescence Analysis

Everything you need to prepare your Thermoluminescence Laboratory, from design to installation, from testing to technical support.

With its offices and laboratories located in the industrial district of Milan, IPSES is specialized in design hardware, firmware and software solutions for scientific instrumentations and customized electronics.

Since many years **IPSES** manufactures and supplies complete laboratories for thermoluminescence analysis for universities and research institutes both in Italy and abroad, providing not only all the necessary equipment, but also advice and training to guide in choosing the best solutions and using the equipment.

Our thermoluminescence laboratories are currently used in: Italian National Institute for the Physics of Matter (INFM); University of Milan-Bicocca; University of Torino; University of Lecce; University of Bari; the Research Institute Pastis CNRSM of Brindisi; the Arcadia - Technologies for Cultural Heritage, Milan; Department of Conservation and Restoration of the Museum of Xian (China); Tubitak Marmara Research Institute - CNRS, Gebze (Turkey); Department of Archeology – National Museum and Library of Myanmar.

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A brief introduction about Thermoluminescence and its applications

The phenomenon of 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 ionizing 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.

Our laboratory installed at the Tubitak Marmara Research Institute - CNRS, Gebze (Turkey).

Application on archaeological findings dating technique

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 alpha, 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, measuring it by a alpha counting system.

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 if 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).

Everything you need to build your Thermoluminescence Laboratory

IPSES devices for thermoluniscence analysis

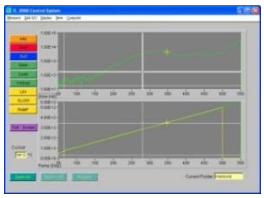
Vacuum tight oven for heating samples and photon detection system.

The oven consists of a strip heater for temperatures up to 650 centigrade degrees, isolated thermocouple, pressure gauge, connections for suction and recirculation of nitrogen with DN16KF flanges and diaphragm equipped with IR filters.
The oven is directly connected to a photon detection system (made by the stage of signal acquisition, a sensitive photomultiplier and its high voltage power supply) able to detect the signal of thermoluminescence emitted from the sample at different temperatures. The system is composed by a photomultiplier of 52 mm, sensitive around 400 nm, complete with housing, filters and signal preamplifier. The system is capable of achieving high speed and sensitivity required by the photon counting.

TL2000: integrated thermoluminescence unit

The temperature control unit TL 2000 is conceived for generating heating ramps extremely reliable, accurate and stable over time, designed to heat samples so to analyze the photon emission of the material at various temperatures. The control of power supplied from the heating element is loop PID type: the error signal, obtained as the difference between the reference temperature at the t instant and the one measured by the thermocouple, is differentiated and integrated. The three components (Proportional, Integral and Differential) are amplified with gains that can be set independently of each other. Their sum is the control signal to the power supply that feeds the heating element. TL2000 unit also manages the acquisition of individual photons detected by the photomultiplier. The instrument, to exploit its potential to the best, is controlled by a computer with high-performance parallel interface IEEE-488 (GPIB). A special data acquisition and control software is installed as to allow the execution of the measures.

Software for the management of TL2000 system.



Integrated measure software for TL dating application: the software can control data acquisition, allows to work on collected spectra and to manage a database of performed measures. Easy and intuitive, the software runs on PCs operating under Windows environment and allows the simultaneous display of the curve of photon detection and of the heating ramp, while also consenting to access to advanced functions for the study and the comparison of the emission curves.

HiVo: adjustable high voltage power supply

This device is designed to provide an adjustable voltage of high value from -320V to -1995V with maximum output current at 2mA, therefore, it is able to provide proper supply to the photomultiplier. HiVo has an LCD with three and half digits indicating the output voltage. The voltage regulation is achieved through a multi-turn potentiometer which can provide excellent sensitivity and precision. The instrument is also equipped with an interlock switch for the high voltage output.

Barpa: fast low noise preamplifier

Barpa is a low-noise preamplifier designed to be used in those applications that require speed and low noise, such as the use of photomultiplier tubes, electron multipliers and other detectors used for photon and ion counting. Thanks to its compact size and low weight, it can be mounted directly on the detector, allowing not to disperse the weak signal along the cable.

IPSES devices for alpha counting analysis

CALPH: alpha counting system

The alpha particle counting system Calph is a stand-alone low level alpha counter used for accurate alpha dose measurements. It is especially conceived for dating application in thermoluminescence analyses.
Calph is equipped with a two single-channel analyzers with adjustable LLD values and a time coincidences unit which allow to discriminate decays of Th232 chain, rejecting fast coincidence pairs due to U238 chain.
The system is equipped with an integrated programmable threshold High Voltage power supply allowing to directly connect the Photomultiplier which will be used for the measurement.
A 42 characters per line impact dot matrix printer is integrated on the front panel to print measure reports.

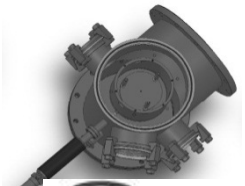
Detection unit for alpha dose measurement

The detection unit is composed of a photomultiplier tube with sensitivity 440 nm, a sample holder/detector with housing for photomultiplier tube and disposable scintillator discs. The housing allows to repair the photomultiplier from any mechanical stress and light during the counting activity. The system is equipped with an integrated voltage divider to provide the appropriate voltages on the dynodes of the photomultiplier. A light safe enclosure and high voltage lock prevent damages caused by accidental opening of the system

Scintillator discs

Scintillator discs with very uniform deposit of silver activated zinc sulfide on mylar sheet. On the scintillator disc is put the powered sample to be analyzed. The discs are specially prepared to give the best analytical response for this kind of applications, both as regards the thickness of the support and the type and density of deposited ZnS: Ag coating.

Systems for sample irradiation and consulting services on types of radioactive sources to be used for



The systems are used to expose the samples to a known radioactive source at fixed times, so to make a comparative measurement of the TL absorbed by the sample over times. This procedure is crucial to achieve the dating of the find. IPSES provides radiation systems for alpha radiation and β sources, designed to hold the source in total safety, without any emission of radiation outside, and to expose the sample to the radiation itself.
In addition, IPSES provides all the necessary advice on the types of radioactive source to use.

Vacuum pump, *speedivalve*, pipes and fittings

The vacuum pump is used both to obtain an inert atmosphere inside the oven for heating the samples through air intake and the subsequent release of gaseous nitrogen inside the heating chamber, and also with the irradiator system with source γ. IPSES, together its systems, provide also the vacuum pump with the necessary features for the use with analysis devices, the pipes and fittings to connect it and the speedivalves to regulate the flows.

Instrumentation for sample preparation: consulting and supply

IPSES provides all the necessary advice for the setting of the laboratory for the preparation of samples to guide its clients to the best instrumental choice. For those who want a single trading partner IPSES directly will supply with all the necessary equipment. In particular:

- Oven to dry the samples
- System for moisture measurement
- Ultrasonic bath
- Magnetic stirrer
- Systems for the sampling, grinding and sieving.
- Analytical balance
- Glasses and holders
- Reagents
- Sample holder discs

Consultancy services for setting up the laboratory. Training for the use of instrumentations, sample preparation for analysis and performance of TL analysis.

Thanks to its long experience and years of collaboration with research institutes in Italy and abroad, IPSES offers consulting services and training course both for the construction of the laboratory and for the use of instrumentations. The training courses, held by researchers with years of experience in the field, provide the scientific support necessary to learn the techniques of sample preparation, perform the analysis and interpretation of results.

Technical support, spare parts, upgrades of the system

When you purchase the equipment to set up a laboratory, they must ensure lasting reliability over the years, because it is always a long-term investments and the equipment is intended for intensive use. Our first laboratories were made and installed 20 years ago, and they continue to be used till nowadays with excellent results, without ever losing in reliability and performance. To achieve these results it is important not only the quality of equipment, but also to have a company who can assist you with excellent customer service for replacement of parts naturally subjected to wear, to perform all the hardware and software upgrade which will be necessary over the years, for example, to interface devices to PCs and new operating systems.
We can also assist you with custom designs for new analytical needs: you will obtain a customized study for your new tools so you can use as much as possible the equipment already purchased, allowing you to meet your needs efficiently, keeping costs down.

Scientific Partnership with

TECNART

Diagnostics Research Group in Cultural Heritage - Department of Experimental Physics, University of Turin - Italy in collaboration with the Italian National Institute for Nuclear Physics (INFN).

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