TASLIMAGE

A HIGH SENSITIVITY NEUTRON AND RADON DOSIMETRY SYSTEM

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We describe a fully-automated neutron and radon dosimetry system developed for both personal radiation monitoring and research. The system is based on TASTRAK PADC plastic, specifically formulated for nuclear track detection. It is easy to use and has a fast readout system, with a throughput of at least 56 detectors per hour. TASTRAK detectors undergo conventional etching in 6.25 M NaOH. No methanol pre-etch is required for neutron dosimetry because the readout software effectively removes all background tracks and rejects other non-track background.
Track recognition is based on the measurement of up to 31 parameters on each candidate track and subsequent dose analysis is carried out automatically. Separate analysis allows spectral information to be obtained where required.
Neutrons are detected by measurement of recoil proton tracks in the plastic, using optical microscopy, image capture and highly sophisticated image analysis software. The neutron response can vary considerably between different exposure conditions in the working environment and differences in the PADC material. This is taken into account by allowing and individual automatic dose calibration of each detector or group of detectors. The normal range of this procedure allows for sensitivities between approximately 150 to 750 tracks/mSv. How this translates to dose threshold depends on the neutron energy spectrum and individual plastic sensitivity, but values of 0.1 mSv (10 mrem) can be obtained.
Alpha particles will leave direct damage in the plastic, and by analysing the tracks present after the etching process, a very precise measurement of the radon concentration can be done, with errors as low as 3%.
TASL has a number of these systems operating internationally as well as running a radon dosimetry service.

The TASLIMAGE Dosimetry System

The TASLImage dosimetry system is a complete laboratory system comprising the TASL*IMAGE* microscope based analysis system, etch tank, drying cabinet, trays and a PC running the analysis software. General features common to both the neutron and the radon dosimetry system will be described here.

The TASLIMAGE is a microscope based track analysis system, which utilise high quality Nikon optics to achieve unprecedented discrimination between tracks and background features. The system is unique in that it analyses and characterises each individual track to produce a dose measurement. The algorithm discriminating an etched track from a background feature (Figure 1) whether it is a scratch, a hair etc., does this by using 31 different parameters relating to the characteristics of a track.

The system can be run as a fully automatic readout system or be used for individual plastic analyses in research environments. The automatic mode, which is normally used for dosimetry services, requires only a button click and will provide a dose measurement for each piece of plastic. User controlled analysis of individual plastics is also possible with a user interface providing numerous options for in depth investigations. The scan data is automatically converted to a dose measurement and the results are displayed in a record database.

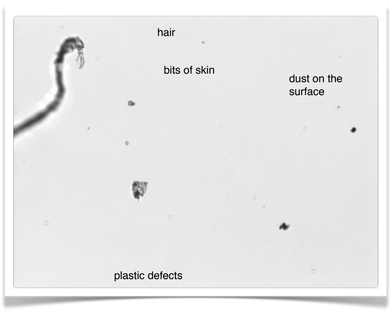


Figure 1 This image has 22 features of various sizes, none of which are real tracks. Amongst the features are hair, dust, skin and defects in the plastic, with the smaller pieces of dust corresponding to the size of a typical neutron track. Labelled defects are easily distinguishable, the most demanding features are small circular pieces of dust.

The system can in addition to reading our own proprietary TASTRAK format detectors also read the "Autoscan" style plastics or be configured for any size plastic, including automatic ID reading.

TASL has developed extra sensitive PADC plastic, TASTRAK, which allows for efficient discrimination from background tracks. TASTRAK is sold worldwide for both neutron and radon dosimetry as well as plasma fusion diagnostics.

TASLIMAGE system specifications

Dimensions (WxHxD): 486 x 440 x 640 mm

Stage area: 203 x 203 mm

Throughput: The analysis time for one detector is 1 minute.

Radon detectors: A tray of radon detectors can hold up to 49 detectors per tray.

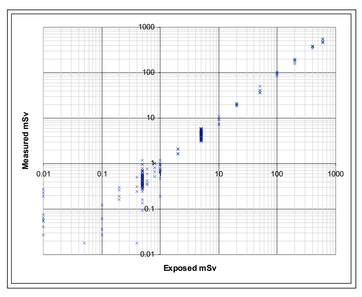
Neutron detectors: A tray of neutron detectors can hold up to 56 detectors per tray.

Optics: Nikon CFI LU Plan Epi 20x objective, Nikon L-IM focusing unit and Nikon standard sextuple nosepiece

The TASLIMAGE Neutron dosimetry System

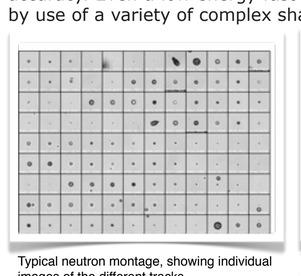
Our neutron dosimetry system can measure doses from 0.1 mSv and has been calibrated up to 600 mSv, showing a linear relationship between exposure and measured dose, Figure 2.

Neutrons with energies from 200 KeV to 14 MeV (fast neutrons) can be reliably detected using PADC plastic detector by means of detecting the knock-on protons from a polyethylene radiator. For thermal- and epithermal neutrons, an additional "radiator" have to be used with the PADC. Etching of the plastics will reveal conically shaped tracks in the detectors which can be analysed for dose determination.
The size of the tracks left behind in the detector is dependent on the detector sensitivity and the subsequent etch conditions, which our system takes into account via a self-calibration procedure. This automatic procedure calibrates the plastics, since the track density varies, allowing for a variation in sensitivity of between 150 to 750 tracks per mSv.

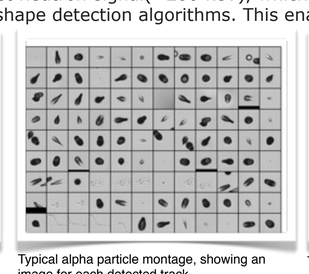


The TASLIMAGE neutron system is linear in its response to the measured dose as shown in above figure.

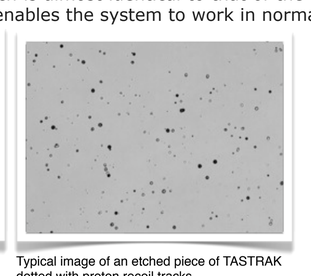
Tracks from recoil protons are typically 3-15 microns. The track sizes overlap with the alpha particle region at large track sizes, where shape differences are used to discriminate particle species. At the small track sizes, it is difficult to discriminate between noise (primarily dust on the surface) and genuine tracks. A variety of shape characterisations are used to achieve the successful discrimination of tracks against backgrounds for up to 2000 background features per cm^2 without compromising the measurement accuracy. Even a low energy fast neutron signal(~200 keV), which is almost identical to that of the background, is distinguishable by use of a variety of complex shape detection algorithms. This enables the system to work in normal laboratory environments.



Typical neutron montage, showing individual images of the different tracks.



Typical alpha particle montage, showing an image for each detected track.



Typical image of an etched piece of TASTRAK dotted with proton recoil tracks.

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Lower detection limit: 5 Bq/m^3

Upper detection limit: 15 MBq/m^3

TASL has a number of these systems operating in the field. For sales enquiries about neutron dosimetry systems, radon dosimetry systems or TASTRAK PADC plastic, please contact TASL, Napier House, Meadow Grove, Bristol, BS11 9PJ,UK or Tel: +44 117 9381172, Fax: +44 117 3720667, E-mail: info@tasl.co.uk
In the Americas and Asia, the TASL*IMAGE* neutron dosimetry system is distributed by the Radiation Detection Company (RDC), 8095 Camino Arroyo, Gilroy, CA 95020, USA. Contact: ron.smith@radetco.com