Technical Specification Sheet: Perspex Dosimeters

The following document is designed to guide you through the storage, instructions for use and specification of Perspex Dosimeters.

Specification

Red 4034 / Amber 3042 Dosimeters for the measurement of radiation dose.

Material:	A single batch of Red 4034 / Amber 3042 Perspex cast polymethylmethacrylate sheets.
Dimensions:	30 mm x 11 mm. Thickness 3±0.55 mm.
Measurement Reproducibility:	**Red 4034** The coefficient of variation of specific absorbance at 640nm wavelength, on sets of dosimeters from the batch, simultaneously irradiated together, in a radiation field uniform within ±1%, is ≤2% over the entire calibrated range, 5 to 50 kGy. **Amber 3042** Coefficient of variation of specific absorbance measurements on sets of dosimeters from the batch, simultaneously irradiated together, in a radiation field uniform within ±1%, is ≤2.5% over the calibrated range 1 to 10 kGy at 603nm wavelength and 10 to 30 kGy at 651nm.
Quality:	Calibration over the calibrated range, all mean specific absorbance data points are: **Red 4034** Within 2% of a fourth-order polynomial least-squares fit to the data. **Amber 3042** Within 3% of a fourth-order polynomial least-squares fit to the data.
Traceability:	Harwell calibration is traceable to the UK standard of absorbed dose at the National Physical Laboratory (NPL).
Shelf life:	10 years from date of release.
Packaging:	Sealed in labelled sachets made of polyester/aluminium foil/polythene laminate, packed in 1,000 per carton. Packing to defined AQL's checked to BSI6001 (ISO 2859.1), single normal inspection, level Ⅱ

Instructions for Use

The dyed-polymethylmethacrylate **(PMMA)** dosimeters have been developed for the measurement of high doses of gamma radiation in industrial radiation processing. The dosimeter incorporates a proprietary dye which causes the Perspex to darken when irradiated. This means that it can be used to measure the dose of irradiation used in radiation processing environments.

Type	Recommended Dose Range	Recommended Read-Out Wavelength
Red 4034	5 to 50 Kilograys (kGy)	640 nm
Amber 3042	1 to 30 kGy	603 nm or 651 nm

The dosimeters are 30 x 11 mm optically clear rectangular pieces of material, conditioned and individually sealed in labelled polyester/aluminium foil/polyethylene laminate sachets. On irradiation the dosimeters visibly darken and the degree of darkening, accurately measurable by spectrophotometry, is related to absorbed (water-equivalent) dose.

The dosimeters are produced in batches. The batch reference numbers or letters are displayed on the dosimeter labels. (For example, 4034 AX is Red 4034 batch AX). Each batch of dosimeters is subjected to rigorous quality-control, checked for conformance with specification, and finally calibrated using a standardised cobalt-60 irradiator and spectrophotometer before release for sale. The standardisation of the irradiator, and the final dosimeter calibrations, are directly traceable to UK National Standards.

INSTRUMENTATION REQUIRED

A good quality spectrophotometer, and a micrometre or dial gauge. It is recommended that these instruments are regularly tested for accuracy by means of standardised glass filters and hardened-steel gauge blocks.

METHOD

1. The dosimeters must remain sealed before, during and after irradiation, until the time of reading. (The packaging material is specially selected to protect the **PMMA** from the effects of extremes of atmospheric humidity).

2. Preferably, the dosimeters should be read within 2 days after irradiation.

3. Select the recommended readout wavelength. For Amber 3042 dosimeters, 603 nm provides higher sensitivity which can be useful up to a dose of 10 kGy.

4. After opening the pack, it is recommended that the irradiated dosimeter is wiped with paper tissue moistened with a suitable solvent such as ethyl alcohol.

5. Using the spectrophotometer, measure the total optical absorbance (A) of the dosimeter. (Air as reference in the case of double-beam instruments). (Note: Corrections for pre-irradiation absorbance (Ao) are unnecessary, and can in fact result in reduced precision).

6. Measure the thickness (t) of the dosimeter.

7. Calculate the specific absorbance A/t. This is normally expressed in units of cm-1 or mm-1, depending on dosimeter type.

8. Using a specific absorbance versus dose calibration graph, table, or polynomial equation, convert each A/t value to derived dose.

9. Less than 1 pouch in approximately 200,000 may be packed with 2 dosimeters. This does not affect dosimeter performance. One dosimeter may be disposed of while the other is read, or a mean of the 2 can be taken if preferred.

ACCURACY OF INSTRUMENTATION

The following are useful (and achievable) goals.

The minimum requirements are:

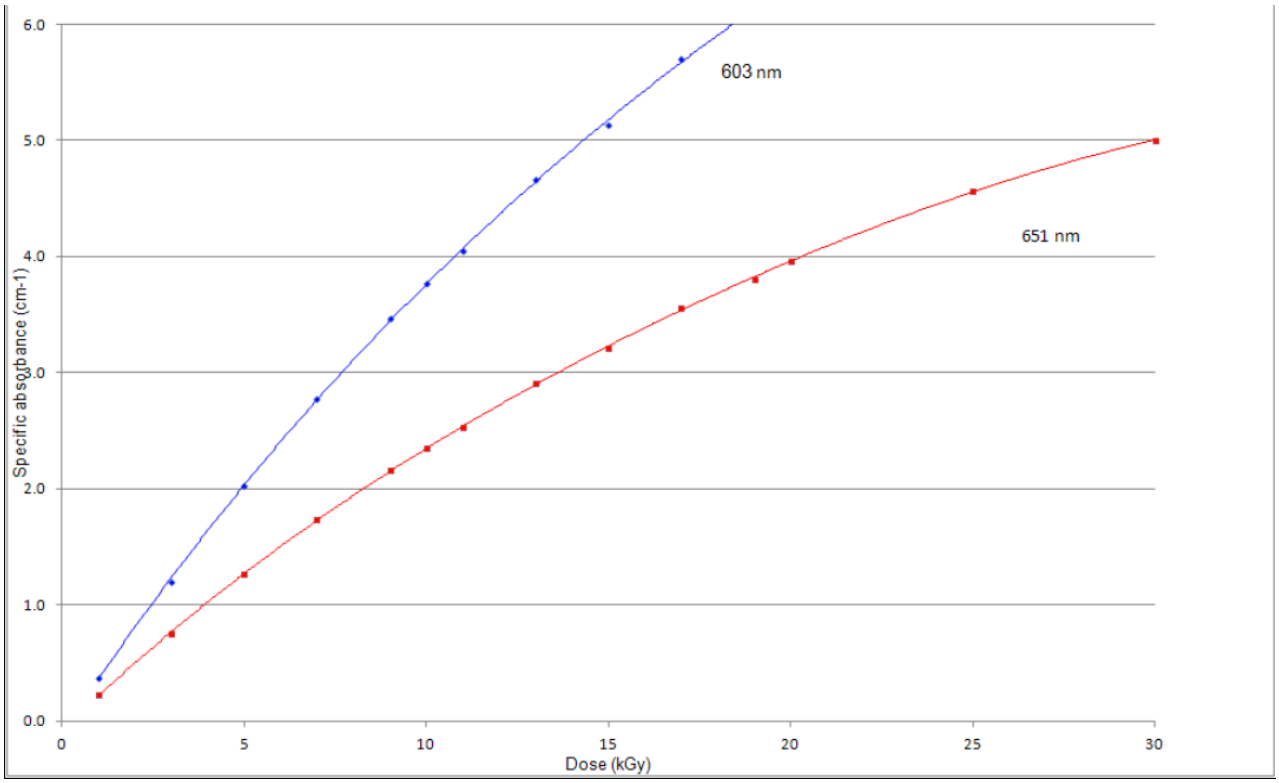
- Spectral slit width maximum 2nm
- Wavelength Required range: The full uv / visible range is normal but at least 400 to 700 nm
- Accuracy ± 1 nm
- Precision ± 0.5 nm
- Photometric
- Absorbance range 3A
- Accuracy ± 2% max ± 1% over as much of the range as possible

CALIBRATION

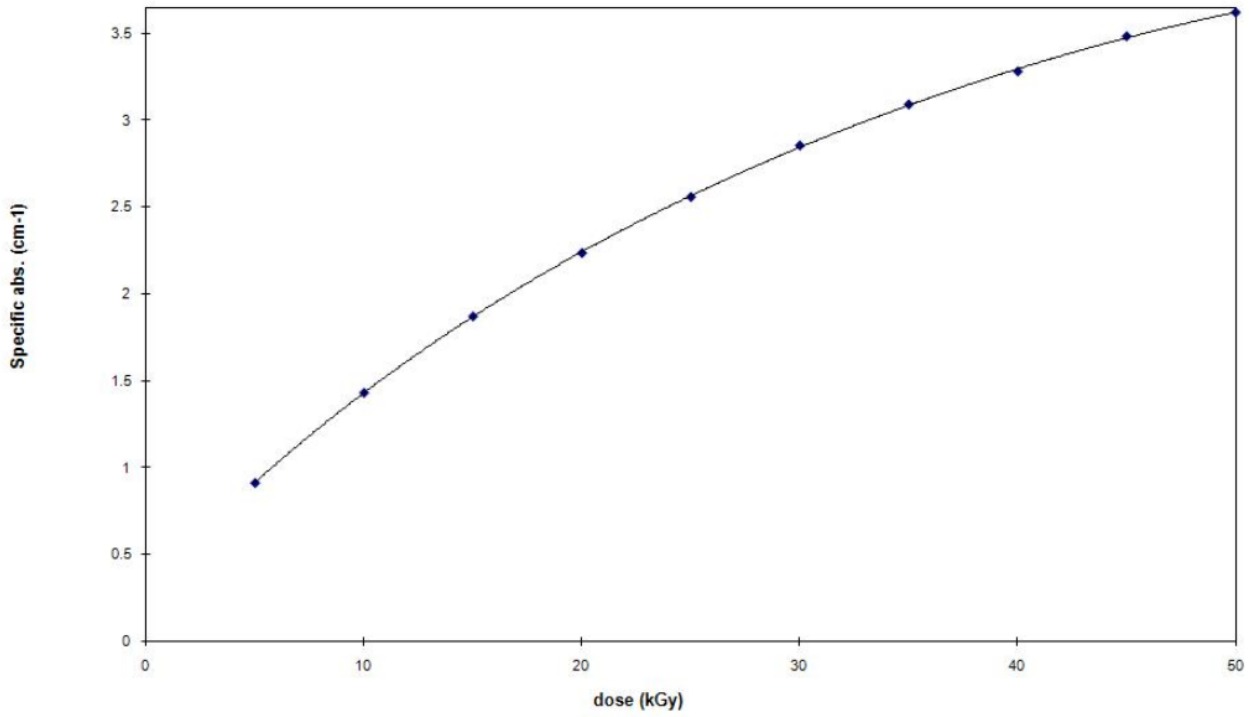
Users are advised to calibrate their stocks of dosimeters, using their own instrumentation. For this purpose, STERIS and national laboratories such as NPL the National Physical Laboratory (UK), and NIST (USA), can irradiate sets of user's dosimeters to accurately known doses.

If the conditions of use are unusual, for example there are exceptionally high or low irradiation temperatures or there are to be delays of several days before measurement, then equivalent calibration conditions should be used.

Amber Perspex 3042 – Example Curve



Red Perspex 4043 – Example Curve



STERIS

RECOMMENDED PRACTICE

A valuable guide to the use of PMMA dosimeters is ASTM 51276 developed by ASTM.

Handling Instructions

- For use with ionizing radiation only.
- Do not mix dosimeter batches
- Handle dosimeters with care and do not use damaged dosimeters
- We recommend that PMMA dosimeters are stored at 20±5°C.
- Humidity is of no concern, as the Perspex is protected by an aluminum foil laminate sachet.
- The temperature recommendation does not imply that the dosimeters are necessarily unsatisfactory if they are stored in conditions outside that temperature range.

As many customers cannot readily comply under all circumstances, for example for dosimeters attached to products in a warehouse before irradiation, we also provide the following additional guidance, in order to provide flexibility, and to avoid being unnecessarily restrictive:

- The evidence is very strong that repeated exposure to temperatures up to 27°C for considerable periods produces no significant effect.
- Brief exposure to a much higher temperature such as 35°C is unlikely to have a significant effect.

Record of Amendment

Revision Number	Detail of Change	Date Changed
1	New Document	28 Dec 2023
2	Addition of 2 Graphs to Page 6	09 Feb 2024
3	Harwell Dosimeters Logo replaced with STERIS logo All references to Harwell removed ISO/ ASTM 51276 updated to say ASTM 51276 Removed 3 Reviewers and 4 Approvers Added 2 new Reviewers and 1 new Approver	April 2026