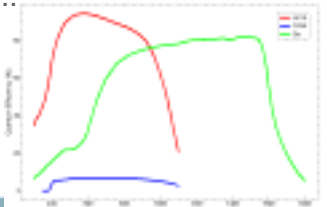
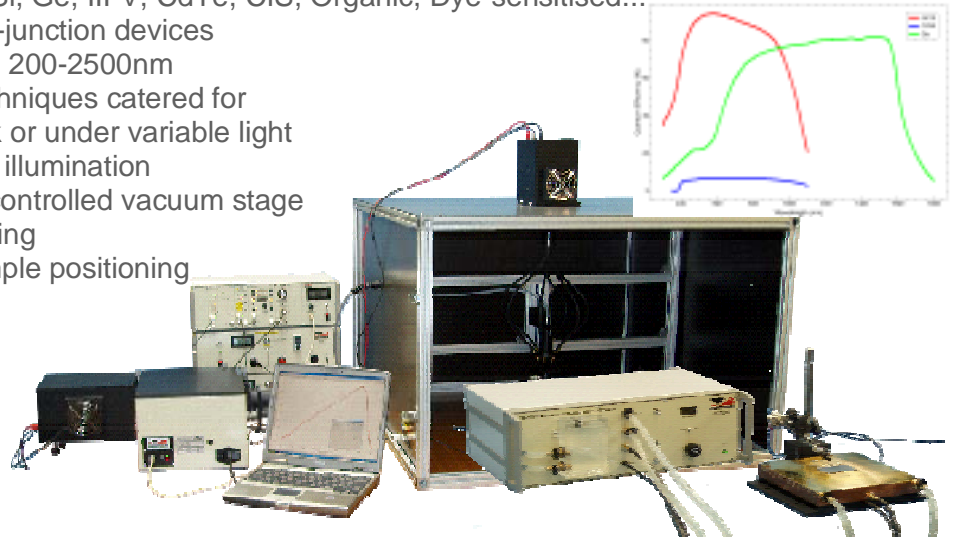


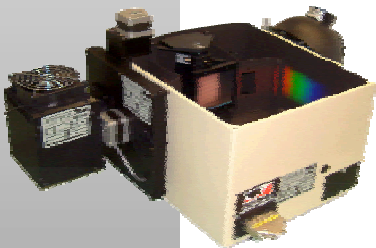
Bentham provides a range of turnkey systems and accessories for the characterisation of all types of solar cell:

- Absolute spectral responsivity/EQE
- Cell reflectance (*for IQE*)
- All cell types, Si, Ge, III-V, CdTe, CIS, Organic, Dye-sensitised...
- Single or multi-junction devices
- Spectral range 200-2500nm
- All probing techniques catered for
- Testing in dark or under variable light bias to >1 sun illumination
- Temperature controlled vacuum stage sample mounting
- Motorised sample positioning



The main elements of such a system comprise:

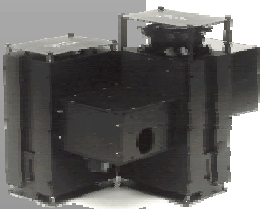
High Throughput Monochromator



The Bentham TMc300, 300mm focal length monochromator is designed for flexibility and high throughput, and is entirely computer controlled.

Up to three diffraction gratings may be mounted on a stepping-motor driven turret to provide measurements over a wide spectral range within one scan.

Dual Source



A dual Xenon-quartz halogen light source, with computer-controlled source selection mirror, is used as the TMc300 input to yield a monochromatic probe source on the sample under test.

The source design is optimised for high throughput throughout the UV to the IR, using the Xenon source to 800nm and the QH lamp above.

Detection Electronics

The monochromatic probe is operated in the AC mode to permit signal recovery, in the presence of a DC bias, by a lock-in amplifier.



Coupling from the sample may be either via a high-current sink amplifier or a transformer stage, the former being that closest to the short-circuit condition of solar cell operation.

A high gain pre-amplifier may be more suitable for measurement of novel low efficiency devices.

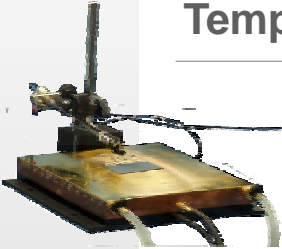
Relay Optic



Light is coupled from the monochromator to a fibre bundle via a relay optic which also houses an optical chopper.

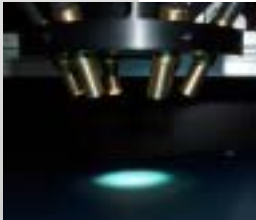
Use of a fibre bundle for light transport to the sample allows for flexibility in the measurement set-up with easy migration between QE, reflectance and PL measurements.

Temperature Controlled Vacuum Stage



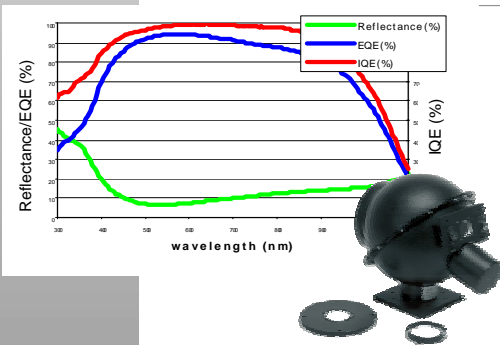
The temperature controlled vacuum stage permits easy sample mounting and electrical probing, whilst maintaining a stable and temperature controlled situation (nominally 20°C) in which to perform measurements. The unit can accommodate the heat generated by exposure of the entire stage area of 200mm x 200mm to an irradiance of 1 Sun.

Bias Light Source



It is important to characterise solar cells under light-biased operation conditions where photo-generated carriers may alter the device response. The bias light source may or not match the solar output, and is typically coupled to the sample plane via a multi-branch fibre bundle to provide a uniform illumination over the cell under test.

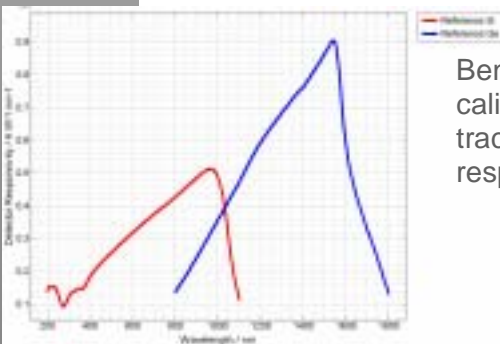
Reflectance Measurement/IQE



Spectral response measurements on their own provide values of external quantum efficiency; to determine internal quantum efficiency, it is necessary to determine how much of the incident light generates carriers.

The total spectral reflectance of the sample is measured with a Bentham DTR6 integrating sphere, in the 0/8° geometry.

Calibrated Detectors



Bentham provides silicon and germanium detectors with transfer calibration against NPL/PTB calibrated devices, ensuring traceable measurements of solar cell absolute spectral responsivity.

Bentham has been manufacturing light measurement solutions for over thirty years, supplying custom systems and standard products globally to industry and research organisations alike in the field of PV research and product testing.