

## Lecture

# Radiometry on Short Wavelength UV Region

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## 1. General

Quantitative radiometry of UV region under 300nm, especially shorter than 250nm, has several technical difficulties.

The accurate and precise measurement may be achieved by ; - (1) accurate radiation standard, (2) stable radiation detector with good response and (3) measurement optics with good efficiency. But, usually these conditions are not obtained at shorter UV region except condition (2). So researchers use unique technics and standard scales to mesurement respectively.

## 2. Spectral radiometry for radiation sources<sup>1)-3)</sup>

Continuous spectral standard (halogen lamp) was calibrated by ETL and spectral irradiance down to 250nm was given by this standard. But irradiance of short wavelength is very weak (about 10nW/cm<sup>2</sup>/nm at 50cm distance at

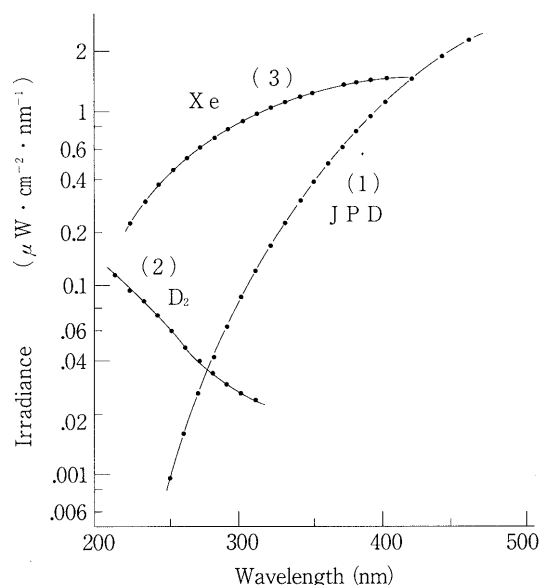


Fig. 1 Spectral irradiance of typical sources

- (1) halogen lamp 500W at 50cm
- (2) deuterium lamp 25W at 50cm
- (3) xenon lamp 500W at 100cm

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250nm) than VIS and IR, so delicate care is necessary to detection and elimination of stray radiation.

Under 250nm, spectral irradiance of deuterium lamps were measured by two different method. One of them was comparison of SOR radiation and another method was comparison of monochromatic radiation by calibrated black detector. However the cross (mutual) checking between these values were not done.

Spectral radiation power of deuterium lamp increases for shorter wavelength and stability of radiation is almost fine, but radiant intensity distribution is not well.

The foreign standard lamps (UV-40 deuterium standard conformity with NBS value) are also imported but mutual deviation of these lamps are fairly large at shorter wavelength (see Fig. 2.).

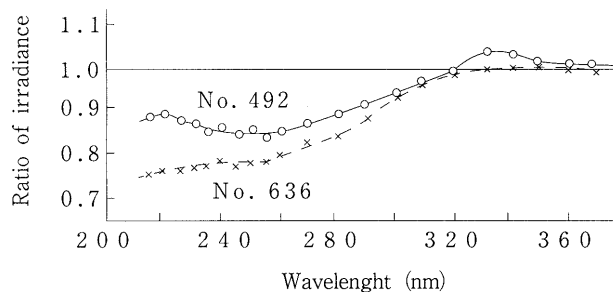


Fig. 2 Mutual comparison of deuterium std.

unity line (ref.) : scale of ref. 2  
No. 492, No. 636 : Uv-40 Std.

253.7nm line (germicidal line) spectrum radiation measurement was done by thermal (black) detector with filters and result of this measurement was agreed within 2% for NIST (NBS) value.

Absorption by oxygen in air is observed under 200nm and transmission of air reduces about 50% in 10 cm path at 185nm (see fig. 3), such absorption can be disregarded at vacuum in 10<sup>-2</sup> torr. 185 nm mercury line radiation also can be measured by calibrated detector with band pass filters.

## 3. Measurement for radiation detectors

Relative spectral responsivity of radiation detectors can be measured by comparison than black detector, for example a gold black coated pyroelectric cell, and good results are obtained down to 185nm.

Certain kinds of silicon photodiodes (SPD) have good spectral response at shorter UV region (see fig. 4). But response change with passage of time are relatively large than that of longer wavelength side.

The absolute responsivity of UV region can be obtained with the combination of absolute responsivity at visible region and relative spectral responsivity through the visible to UV region.

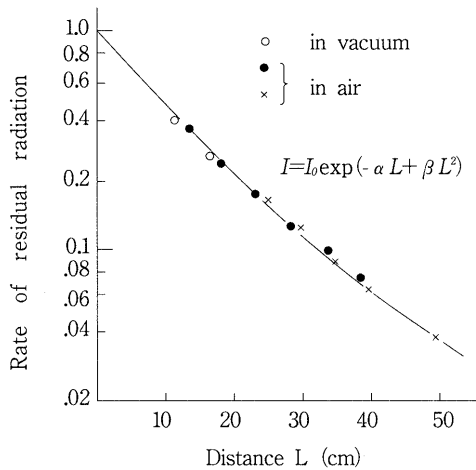


Fig. 3 Attenuation of 185nm radiation in air

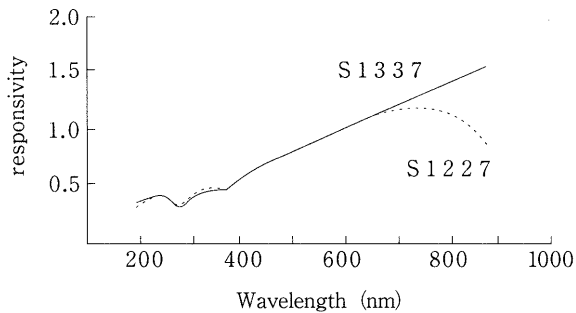


Fig. 4 Spectral responsivity of SPD

The absolute responsivity is measured by SPD self calibration method or total irradiance by luminous intensity standard with wide band pass filters.

The mutually (cross) checking of radiative and detective radiant power scale (value) may be done by combination of stable reference monochromatic radiation with good irradiance uniformity and spectral radiometric system as shown in fig.5.

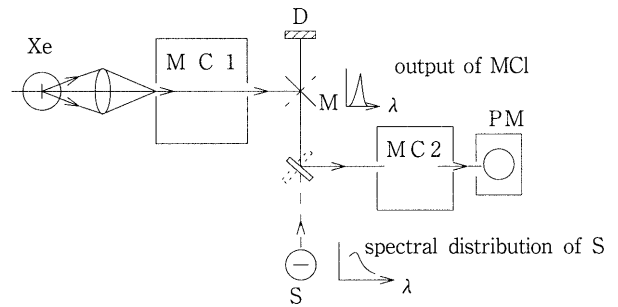


Fig. 5 Mutual checking system of radiation and detection

Output monochromatic radiation of MC1 is measured by Std. detector D and is compared with std. source S by 2nd monochromator MC2, again,

**Reference**

- 1) Nishi M., et al : Spectral radiometry of deuterium lamps, 1976 Conference Tokyo div. Illum. Engng. Inst. Japan, 25, (1976) (in Japanese)
- 2) Nakagawa Y., Ohtani F. : The Measurement of spectral irradiance in short UV region down to 200nm, J. Illum. Engng. Inst Japan, 59-9 (1975) 462, (in Japanese)
- 3) Nakagawa Y., Ohtani F. : The Measurement of spectral irradiance on short UV region by thermal detector and monochromatic radiation, Sci. & Engng. Rep. Saitama Univ. Ser. C No.8, 28 (1974)