Topic number: 5

SPECTRORADIOMETRIC CALIBRATION OF SYSTEM FOR DIAGNOSTICS OF DC GLOW DISCHARGE USING METHOD OF RAYTRACING

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The excited atomic or molecular species which are to be studied by means of emission or absorption spectroscopy can play important role in low-temperature plasma generated by DC glow discharge. Spectra enable us to identify emitting particles and to determine their temperatures and densities. Spectroradiometric calibration of the system for emission spectroscopy using the source of radiation with defined course of absolute spectral irradiance in the range from 250 to 1700 nm has been performed. The method of raytracing enables to determine the portion of the total radiation used for spectral analysis, i.e. the portion processed by optical fiber. The geometry of the discharge tube is described in greater details e.g. in [1]. Tungsten halogen lamp LSK116 (200 W, 6,6A) produced by L.O.T. Oriel GmbH operated using power supply Konstanter SLP 240-40. Calibration of this lamp has been performed at testing laboratory of Heraeus Noblelight GmbH. Spectral irradiance at the distance of 700 mm has been measured [2].

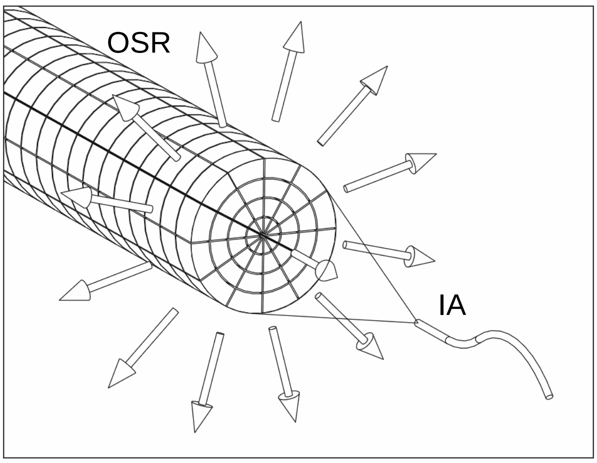

Fig. 1: Segmentation of source of radiation (OSR-omnidirectional source of radiation, IA-input aperture).

The source of radiation is considered to be a cylinder radiating uniformly inside its volume total radiant flux into the space Φ_t=1. This source, corresponding to the central part of the discharge tube, is divided into 10 segments radially and into 10 segments angularly (Fig.1).

The number of these elements is variable. Each of them emits radiant flux Φ_i proportional to its volume given by

$$\Phi_i = \frac{V_i}{V_t}\Phi_t \tag{1}$$

where V_t is the total volume of the cylindric source and V_i is the volume of the segment. This segment is replaced by a point source placed in its centre which emits radiant flux corresponding to the entire segment. This source is assumed to be omnidirectional uniformly radiating to all directions with constant radiance I_i which is equal to

$$I_i = \frac{\Phi_i}{4\pi} \tag{2}$$

The input aperture of the system is divided into segments analogously. Greater details are described in [3]. Raytracing is processed at programming environment Visual Basic for Application version 6.5. The examples of the results of tracing are shown in Figures 2 and 3. The inner diameter of the discharge tube is 21.5 mm, the height of the cylinder is 390 mm. The axis of the quartz fiber (diameter 0.2 mm) is perpendicular to the center of the tube window at the distance 50 mm.

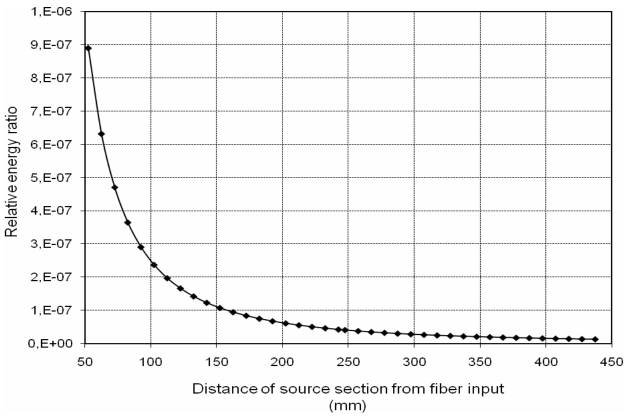

Fig. 2: Dependence of relative energy ratio on distance of source section from fiber input.

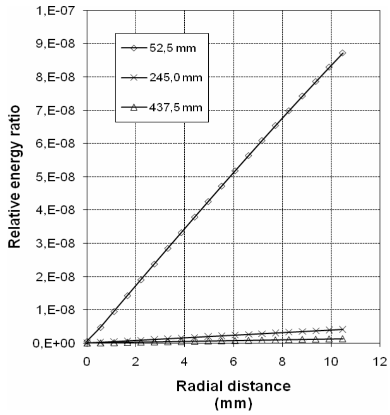

Fig. 3: Dependence of relative energy ratio on radial distance of source segment from tube axis for various distances from fiber input.

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Reference

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[2] Test Report No.20070, 2008, Heraeus Noblelight GmbH, Germany
[3] A. Kaňka, V. Hrachová, J. Zicha and J. Čáp, 2006 Czech. J. Phys. **6** 619