Measurements of Transfer Standards for Radiometry at Inmetro

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Abstract: We present results on the measurement of properties of transfer standards which are based on trap detectors. The aim is to improve the traceability chain for the field of radiometry at Inmetro. Future needs and perspectives for the development of this field are discussed.

Key words: cryogenic radiometer, radiometry, optical measurements standards.

1. INTRODUCTION

Determination of spectral responsivity of silicon transfer standards are of overwhelming importance for the fields of photometry and radiometry [1,2]. Inmetro had recently established a cryogenic radiometer as a primary standard for the calibration of silicon trap detectors [3].

The aim of this work is to show some results on the measurement of properties of these transfer standards, as well as to present future perspectives for the field of radiometry at Inmetro.

2. SPECTRAL RESPONSIVITY OF TRANSFER STANDARDS

The power spectral responsivity of silicon detectors is defined as the ratio of the generated current, I, by the optical power (P) inciding on its surface:

$$s(\lambda) = \frac{I}{P}; \left[\frac{A}{W}\right] \qquad (1)$$

The method used for determining the spectral responsivity of detectors is based on the measurement of the optical power of a laser with a spectrally flat response detector, an electrical substitution cryogenic radiometer (ESCR).

It is worth mentioning that the traceability to both parameters, current and optical power, is given by electrical quantities.

Usually, several wavelengths are used in the measurement to cover the spectral range of interest and depending on the aimed application.

Fig. 1 shows one of the results for the measurement of responsivity of a silicon trap detector performed for some lasers wavelengths. Relative expanded uncertainties are smaller than $8 \cdot 10^{-4}$ for these data. Furthermore, in this range, the responsivity increases linearly with wavelength.

The complete characterization of the cryogenic radiometer system at Inmetro was already performed and the results, including the evaluated uncertainty showed good agreement with the reported by other National Metrological Institutes (NMIs). Also, due to this work, the Optical Metrology Division (Diopt) of Inmetro could conclude the realization of the SI base unit of luminous intensity, the candela.

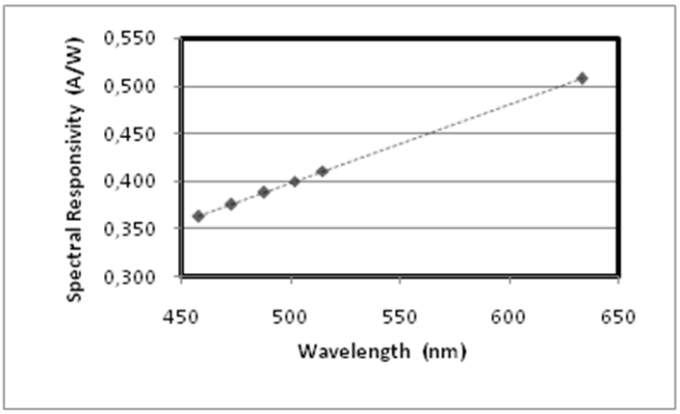

Fig. 1. ***Spectral responsivity of a trap silicon detector at some wavelengths of Ar^+ and HeNe lasers.***

3. PERSPECTIVES

Future needs for Brazilian metrology are encouraging to further develop radiometry at Inmetro. In particular, we are in course of a bilateral comparison with a NMI in order to validate results and to have a link with BIPM Calibration and Measurement Capabilities.

Diopt is developing a project in order to provide traceability for laser and other light sources, commonly used in biomedical applications. Preliminary studies pointed out that a better characterization of the light emitted by those equipments should be performed [4]. For diagnostic and therapeutic laser equipment, there have been a particular safety standard since 1992, in which its third edition of 2007 included essential performance requirements, emphasizing the need of accurate energy delivery (NBR IEC 601-2-

22:2007) [5]. Nevertheless, measurement of parameters such as beam divergence and diameter, pulse duration, pulse repetition rate, among others, not included on the standard requirements, should be studied for a reliable medical use to be achieved. Concerning the intense pulsed light equipment (IPL), a non-laser source in use for medical applications since 1994 that causes hazards which are similar to those of the laser, the International Electrotechnical Commission has just published a related particular standard (IEC 60601-2-57:2011) [6].

Infrastructure developments providing accurate characterization of these optoelectronic equipment routinely used by healthcare professionals is essential to avoid adverse events and to assure reliable diagnostics and treatments [7].

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