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Increasing optical absorption measurement reliability in pulsed plasmas

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Determination of the absolute concentrations of the atomic or molecular particles in gaseous discharges is one of the most important plasma diagnostics tasks, for which Resonant Optical Absorption Spectroscopy (ROAS) is often used. This technique is based on measurement of the absorption of light coming from an external source and passing through the discharge of interest. ROAS method faces some difficulties in the pulsed plasmas, however, when the particle density has to be determined in the bright discharge area, e.g. in the arc plasma, high-power sputtering plasma, microwave discharge, etc. These difficulties are mainly related to the lack of intensity and stability of the reference light source used for absorption.
In this work we propose the solution targeted to increase the measurement reliability during the particle density determination in the pulsed discharges by ROAS technique. A special way of synchronization between a gated light detector and two pulsed discharges, representing the discharge of interest and the reference source, is developed. In the proposed method, called “dynamic source triggering”, light from the pulsed reference source is precisely synchronized with the gates of a sensitive optical detector, passing through the discharge of interest only when necessary. This allows utilizing short-pulse plasmas for the time-resolved ROAS measurements, which dramatically increases the intensity of reference source as well as the total reliability of measurements.
In addition to the dynamic source triggering, the absorption measurements can be further improved by using the simultaneous spectral detection, as also demonstrated in this work. The proposed methods are illustrated by the time-resolved ROAS measurements of the metal atom density in a high-power impulse magnetron sputtering (HiPIMS) discharge, using either a hollow cathode lamp or another HiPIMS discharge as a pulsed reference source.

Keywords
absorption spectroscopy
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dynamic triggering