Synchronised fast optical and electrical diagnostics for pulsed-driven atmospheric pressure discharges

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Low-temperature plasmas serve a wide array of applications, ranging from surface modification techniques to biomedical fields, where atmospheric pressure discharges are frequently utilised. In many plasma-generating devices, the initiation and evolution of the discharge occur on a (sub-)nanosecond timescale. The processes occurring during the breakdown are critical as they determine the generation of reactive species, which are essential for initiating effective plasma chemical reactions.

Consequently, very fast diagnostic methods are required to resolve the spatial and temporal evolution of pulsed-driven discharges at atmospheric pressure, thereby providing insights into fundamental discharge properties on a sub-nanosecond timescale. This contribution highlights the benefits and immense potential of sub-nanosecond optical diagnostics combined with fast electrical measurements. As an example for state-of-the-art emission-based techniques with picosecond resolution, the working principle of a streak camera system is described in detail.

The application of synchronised optical and electrical diagnostics proves to be a powerful approach to determine fundamental discharge parameters. With these methods, essential data can be obtained that enable an in-depth understanding of the fundamental discharge properties. This will be illustrated by case studies featuring atmospheric pressure discharges. In addition, the results can be used for a comprehensive validation of simulation models and thus contribute to the improvement of these simulations.