Probing gas phase chemistry in atmospheric pressure plasma jets: Experiments and simulations

S. Schröter[1], J. Bredin[1], A. R. Gibson[1,2], K. Niemi[1], A. Wijaikhum[1], A. West[1], M. Foucher[2], Y. Gorbanev[3], H. Davies[1], N. Minesi[1], N. de Oliveira[4], L. Nahon[4], D. Joyeux[4], J. Dedrick[1], J.-P. Booth[2], V. Chechik[3], E. Wagenaars[1], T. Gans[1], D. O'Connell[1]

[1] *York Plasma Institute, Department of Physics, University of York, York, YO10 5DD, UK*

[2] *Laboratoire de Physique des Plasmas, Ecole Polytechnique-CNRS-Univ Paris-Sud-UPMC, Universite Paris-Saclay, 91128 Palaiseau, France*

[3] *Department of Chemistry, University of York, York, YO10 5DD, UK*

[4] *Synchrotron Soleil, l'Orme des Merisiers, St. Aubin BP 48, 91192 GIF sur Yvette Cedex, FR*

Atmospheric pressure plasmas (APPs) have a great number of potential applications in industry, biomedicine, and environment, due to their variable chemistry and low gas temperatures. In particular, reactive oxygen, nitrogen, and hydrogen containing species (RS) are known to be important for these applications. However, quantification of these species under typical atmospheric conditions is often challenging due to high collision rates and mixing with ambient air, effects which limit the accurate application of several commonly used diagnostic techniques in low-pressure regimes.

In this work, advanced experimental techniques to quantify RS in APPs and their effluent will be introduced, namely absorption spectroscopy in the UV and VUV spectral range, and picosecond two-photon absorption laser induced fluorescence. These diagnostic techniques are capable of circumventing the limitations described above while additionally providing the high spatial and temporal resolution required for the study of APPs. Furthermore, by combining experimental results with plasma simulations additional insight can be gained into the chemical kinetics of the plasma. Results of a 0-dimensional plasma model are benchmarked against species densities such as O, H, OH, and H_2O_2 measured using the techniques described above. The model is then used to identify the main production and consumption pathways for these species and other species of interest. Knowledge of these pathways allows us to identify operating regimes for the optimisation of the densities of various reactive species. In addition, our results demonstrate that reactive species formation can be strongly influenced by impurities in the gas flow.

Acknowledgements The authors acknowledge support by the UK EPSRC (EP/K018388/1 & EP/H003797/1) and the York-Paris Low Temperature Plasma CIRC. This work was performed within the LABEX Plas@par project and received financial state aid, managed by the Agence National de la Recherche as part of the programme "Investissements d'avenir" (ANR-11-IDEX-0004-02).