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Chemical kinetics and density measurements of OH in an atmospheric pressure He + O_2 + H_2O radiofrequency plasma

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Densities of OH in a RF driven atmospheric-pressure plasma were measured and modelled in a plane-parallel geometry, in helium with small admixtures of oxygen and water vapour ($He+O_2+H_2O$) [1]. The OH density is measured under a wide range of conditions by absorption spectroscopy, using an ultra-stable laser-driven broad-band light source [2]. This light source has a high intensity and excellent temporal intensity stability, leading to an absorption baseline variability lower than 2×10^{-5} over the range of the OH(X)→OH(A) transition (306-311 nm) [2]. This setup allows a detection limit one order of magnitude lower than the typical limit (about 10^{-3}) that can be achieved with the more commonly used UV-LEDs [3]. These measurements are compared with 0D plasma chemical kinetics simulations adapted for high levels of O_2 (1%). It was found that the addition of O_2 has a weak effect on the OH density because, while atomic oxygen becomes a dominant precursor for the formation of OH, it makes a nearly equal contribution to the loss processes of OH. The small increase in the density of OH with the addition of O_2 is instead due to reaction pathways involving increased production of HO_2 and O_3. The simulations show that the densities of OH, O and O_3 can be tailored relatively independently over a wide range of conditions. The densities of O and O_3 are strongly affected by the presence of small quantities (0.05%) of water vapour, but further water addition has little effect. Therefore, a greater range and control of the reactive species mix can be obtained by the use of well-controlled multiple gas admixtures, instead of relying on ambient air mixing.

References

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