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The Torche a Injection Axiale (TIA), i.e. torch with axial gas injection, was developed by the group of Moisan in 1993 [1]. This plasma seems to be very promissing for atomic emission spectroscopy [2]. Here, we report on the investigations on two different kind of plasmas created by the TIA: one with helium and the other with argon as main gas. These plasmas expand in the open air and are typically 10 cm long and 2 mm in diameter.
The electron temperature and the electron density are determined using Thomson scattering. In the plasma with helium as main gas, temperatures around 25000 K and densities between 0.64 and 5.1 $\cdot$ 1020 m 3 are found. In an argon plasma the electron temperature is lower and the electron density is higher: 17000 K and around 1021 m 3 respectively [3].
Using these results, it can be established that the ionisation rates of both plasmas are much larger than the recombination rates, which means that the plasmas are far from Saha equilibrium. However, the production of new ions and free electrons outranges by two orders the estimated "classical" losses due to flow and diffusion.
Spatially resolved Thomson scattering measurements on this small plasma show that the plasma has a hollow structure. This means that the diffusion losses were originally underestimated, since the steep outer gradients enhance the losses due to diffusion. This can explain the high electron temperatures in the helium plasma. However in the argon plasma the ionisation remains one order of magnitude larger than the destruction of electrons. The high loss rate is confirmed by interuption experiments [4]. This means that there is a third process (besides diffusion and recombination) which can not be neglected. The possibility that this third process is mixing with the surrounding air is investigated.

References

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