# Low-density plasma channels generated by the femtosecond pulses

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Femtosecond pulses are well known to propagate in the atmosphere over several tens of meters as plasma channels (filaments). The basic principle of this self-guiding is a dynamical equilibrium between self-focusing due to the Kerr effect and defocusing effects due to the laser plasma generation. The plasma channel is induced along the propagation of the fs laser pulses, by multiphoton or tunneling ionization of medium. For theoretical description of fs laser propagation through different media the complete dynamic between self-focusing, diffraction and ionization have to be involved in solving the nonlinear Schrdinger equation *(NLS)*. Since the free charges contribute in diffraction process, it is crucial to determine their concentrations for any further analysis of the fs laser propagation.

In our paper [1] we have characterized the plasma channel formed in the trail of an intense femtosecond laser pulse propagating through the low pressure helium, air and nitrogen gas. Relaxation times of the generated plasma channel up to 60 $\mu$s were measured, depending on the gas, concentration and applied voltage between the electrodes. From the solutions of the kinetic model for charged particle concentrations we concluded about the dominant mechanisms presented in our experimental system. By instantaneous laser ionization the initial electron density $n_e(0)$ is created. The $n_e(t)$ decay exponentially in time predominantly due to the electron-attachment of neutrals. In low density plasmas the recombination processes do not play crucial role as in the case when the plasma is generated at atmospheric pressure.

For the theoretical calculations of the measured time-dependent plasma channel a mathematical model proposed in [2] based on the equivalent current circuit is used. By comparing the calculated and measured time-dependent $U_{OSC}(t)$ voltage, the electron-attachment coefficients $\eta$ and the initial electron densities $n_e(0)$ for a given conditions are obtained. The electron densities in the $10^8$-$10^9$ cm$^{-3}$ range are found. The electron-attachment rate coefficient $\eta$ and the $DC$ plasma channel conductivity are in good agreement with the previously reported values.

## References

[1] N. Vujicic, H. Skenderovic, T. Ban, D. Aumiler, G. Pichler, App. Phys. B, **82**, 377 (2006).
[2] H.D. Ladouceur, A.P. Baronavski, D. Lohrmann, P.W. Grounds, P.G. Girardi, Opt. Commun., **189**, 107 (2000).