Review of a doctoral thesis
"Electron-ion recombination at temperatures below 300 K"
written by Mgr. Tomáš Kotrík

The doctoral thesis of Tomáš Kotrík: "Electron-ion recombination at temperatures below 300 K" presents the study of the recombination processes using the modified experimental setup based on a principal of the flowing afterglow instrument with the ability to control flow tube temperature.

The scientific power and versatility of the flowing afterglow technique was proved by many successful experiments and the impact of this technique to the ion chemistry is enormous. Despite the fact that the principle of the flowing afterglow was discovered quite many years ago the constantly modified experimental setups are using all around the world. Several versions of such instruments were developed in Group of Elementary Processes in Plasma at Charles University in Prague member of whom the author of thesis is. Data from three versions of this instrument are presented in the thesis. The last version called Cryo-FALP II is able to control flow tube temperature in the range 40 – 300 K.

The thesis is mostly experimental but the calculation for chemical kinetics model of plasma formation and some theoretical results explaining the recombination processes are also presented.

Despite the fact that the title of the thesis at first glance could look too common for the doctoral thesis I'm taking into account complexity of presented work and agree with the chosen title. May be the adding to the title something that determine the principle of experiment would make it more specific. The abstract is very well written and describing all main points of the thesis with some details.

The thesis contains introduction, five main chapters, summary and the list of publications. At the time the thesis completing the candidate has twenty five scientific papers published in peer reviewed journals. Five of them are also attached to the thesis.

First chapter presents briefly but clear enough the introduction into the theory of electron-ion recombination and historical overview of the experimental and theoretical studies of recombination processes.

Second chapter presents the description of the experimental technique. Detailed information about instrument modification, experimental procedure, data acquisition together with data analysis and safety system is presented.

Three following chapters are dedicated to experimental study of recombination of H_3^+ and D_3^+ dominated plasma at temperatures 77 – 300 K, recombination of HCO^+ and DCO^+ dominated plasma at 150 – 300 K and recombination of Ar^+ dominated plasma at temperatures 50 – 300 K with electrons. Each of these chapters is supported by several publications in peer reviewed journal included in author's publication list.

The thesis is written in very good English. Sentences are very well structured. Writing has very readable and clear style. There are some grammar errors which I'm considering just as misprints (like in equation **5.1**). It was actually very difficult for me to find any objections to grammar or syntax in presented thesis.

All major statements or experimental results are always supported with references form current or close to the current issues of scientific journals and not only by own one but from the other research groups. There are many schemes presenting the details of the instrument or principle of the experiment making it easier for understanding. Figures, tables and captions to them are informative and very well presented. Perhaps at least one Langmuir probe characteristic with brief explanation could be included and probably **Table 4.1** should have the reaction of ArH^+ formation.

Big attention paid to proper data acquisition and interpretation. Factors that can affect proper experimental condition like gas impurities and temperature stability along the flow tube are explained. Additional method for proper data interpretation was developed. Author also critically mentioned that at this moment not everything, like the drop of measured effective rate coefficient for H_3^+/D_3^+ ions at lower concentrations of H_2/D_2, can be understood and that the further work should be done.

Discovering the effect of buffer gas on recombination rate allows separating and measuring the binary and ternary recombination rate coefficients for H_3^+ and D_3^+ ions in condition of flowing afterglow plasma experiment. Obtained values for the binary recombination rate coefficient are in good agreement with the data obtained from beam experiments and the theory. The H_3^+ enigma cannot be considered solved without achieved agreement with all theory, beam experiments and the plasma experiment presented in this thesis.

Describing the measurement of temperature dependencies of the recombination rate constant the afterglow plasma considered to be thermalized with the flow tube wall. **Chapter 5.3.3** presents discussion about estimation of electron temperature T_e based on analyzing of ambipolar diffusion in Ar^+ dominated plasma. Can the author comment the possibility of measurement T_e from the measured Langmuir probe characteristics?

Results of chemical kinetics model of afterglow plasma are nicely presented for all studied ions. It would be nice to see the correlation between the model and the real experiment by adding the experimentally measured $n_e(t)$ to the same figure where calculated model was presented.

Considering the scientific content and the author's contribution I do believe that presented work of Mgr. Tomáš Kotrík corresponds to the standard of a doctoral thesis and permission for a public defense of the thesis can be granted.

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