A great interest on the application of vacuum interrupter (VI) in medium and even high-voltage application leads to increase of comprehensive and fundamental research on VIs. Application of these interrupters is however hindered by limitation of interrupting capability, when high-current anode phenomena occur. The goal of the work is to investigate the high-current anode phenomena using spectroscopic methods as well as electrical measurements. The highlights of this PhD theses are presented as follow:

- The impact of several vacuum interrupter properties including electrode diameter, gap geometry, contact opening time and speed on the formation of high-current anode phenomena has been investigated systematically. Threshold currents together with corresponding gap lengths of the formation of high-current anode modes are determined for AC frequencies of 50, 100, 180, and 260 Hz and pulsed DC over 5 and 10 ms. The influence of various abovementioned parameters are investigated using existence diagrams. The results show that both instantaneous current and transferred charge are important for the formation of high-current anode phenomena. Nevertheless, the formation of high-current anode modes is dominated by current in case of high frequency pulses and by arcing time in pulsed DC.

- A new type of high-current anode modes, anode spot type 2 is found and described for the first time. Anode spot type 2 can be distinguished from the known anode spot (type 1) and from the intense mode by its characteristic behavior concerning arc voltage and light emission near the electrodes. In contrast to anode spot type 1, both anode and cathode are active in case of anode spot type 2. Comparing to anode spot type 1 and intense modes, anode spot type 2 occurs at higher gap lengths. Moreover, an abrupt increase of 10-20 V in the arc voltage appears during transition to the anode spot type 2.

- Video spectroscopy is used to investigate the distribution of atomic and ionic lines near the anode, the cathode, and in the inter-electrode. The results show a similarity in both AC and DC types of waveforms. Some unique changes appear during transition between different modes in both waveforms, e.g. an abrupt change in Cu III emission lines, is recorded during transition from footpoint mode to anode spot type 1 mode. Moreover, noticeable increases of the intensity of all species are observed during transition to anode spot type 2.

- Physical parameters of the plasma, e.g. radiating density, ground state density and electron density are determined during anode spot type 1 and type 2 using optical emission spectroscopy.

- Transition to anode spot type 2 is investigated with respect to transferred charge, aspect ratio, existence diagram and distribution of atomic and ionic lines. In fact, a transition from anode spot type 1 to type 2 is dominated by the ratio of electrode diameter to gap length (aspect ratio). Nevertheless, increasing the current can
decrease the aspect ratio which is necessary for the formation of anode spot type 2.

- A unique consequence of anode spot type 2 is the possible appearance of another new phenomenon, the anode plume. It appears immediately after extinction of anode spot type 2, i.e. just before current zero, and is characterized by a voltage decrease of about 10 V. Optical emission spectroscopy confirms that the anode plume consists of a cloud in the front of the anode surface formed by metal vapor from the anode that is covered by a shell of single charged ions. The radiating densities of Cu I and Cu II and the temporal evolution of the plasma temperature are determined inside the anode plume. Both density and temperature decrease by extinction of anode plume, i.e. under strong decrease of current. The formation of an anode plume is stable from shot to shot in case of CuCr electrodes but not in case of Cu electrodes.

- Ground state densities of Cr I resonance lines are determined after current zero as well as in the active phase using broadband absorption spectroscopy. In case of extinction of anode spot type 2 the density around current zero of about 2.4×10^{18} m^{-3} decreases by about factor of five within the next 3 ms. During active phase, the density for anode spot type 2 is about 6 times higher than for anode spot type 1. The Cr ground state density during anode plume at about 200 µs before current zero is noticeably higher than at current zero. Moreover, the ground state density of Cr at about 100 µs after current zero is compared for two cases with and without anode plume. It is about two times higher in case of anode plume.

- It is shown that conventional arc models, e.g. Mayr, Cassie, Schwarz, Schavemaker, and KEMA are not able to trace the arc voltage of high-current vacuum arcs, especially its abrupt change during transition between anode modes. Therefore, a new electric arc model is proposed which can trace the arc voltage of vacuum arc even during anode spot type 2. Besides, this model has predictability characteristics due to application of predictable existence diagram to the model. Thus, the arc voltage can be traced within quite different interrupting current ranges.

- These results can be used to propose a physical model which can explain the formation of different high-current anode modes especially the new ones, i.e. anode spot type 2 and anode plume. It is expected that LTE condition are not valid in case of high-current vacuum arc. So, a non-LTE model can be developed to explain high-current anode phenomena in more details from physical point of view.