DESCRIPTION FOR THE GENERAL PUBLIC

In everyday life we used to see the matter in a solid, liquid or gaseous state. Despite this, most of the visible universe (according to some estimates up to 99%) consists of plasma. It is similar to a gas in the sense, that it has no defined shape or volume. While in the ordinary gas electrons are strongly associated with the nuclei, whereby the electrical conductivity is practically zero, the plasma consists of a positive and negative charge. Therefore, it conducts electricity, but globally is electrically neutral.

In order to change gas into plasma the energy, which is greater than the ionization one, must be delivered. The plasma is formed not only as a result of natural processes, but can also be produced artificially in the laboratory. Typically, this is achieved by applying a direct or alternating voltage on the electrodes. In such created electric field free electrons, present for instance thanks to the existence of cosmic rays, collide inelistically with molecules gas, ionizing it. Released electric charges participate in further process and sustain the discharge. Such created plasma can be used for processing and modification of materials and for the chemical analyzes.

In recent years, more and more attention has been paid to the possibility of generating plasma not in conventional, large reactors, but in miniature devices. A great convenience of such structures is the ability to increase the pressure range under which such devices can work. This restriction describes Paschen's rule. It states that in order to ignite the discharge in the higher pressure gas, with remaining voltage at constant level, reduction in the distance between electrodes is required. Fabrication of such miniature devices is possible thanks to the development of microsystem technology. Currently, the base material for their construction is usually silicon, glass, and recently also polymers. But keep in mind that the discharge region is exposed to damage resulting from the nature of plasma.

In terms of reliability and stability in function of the temperature one may distinguish ceramic materials. In microsystems technology for several years, are conducted intensive studies into the possibilities of Low Temperature Cofired Ceramics (LTCC). It is a composite material which before burning is composed of grains of ceramic, glass and polymer. The organic component makes that in raw state, before firing, the ceramics takes the form of flexible sheets and can be easily micromachining. Additionally, on these layers one can deposit variety of materials having different electrical (conductive, dielectric) and sensing (eg. temperature) properties. It is also possible to assembly optoelectronic and integrate electronic components. Thanks to the above features of this technology it is possible to perform complex, multi-layer systems for chemical and biochemical analysis.

The aim of this project is to design and examine the miniature devices for the generation of plasma at atmospheric pressure. Particular emphasis will be placed on the study of the influence of the structure of the device and parameters of the signal changes in plasma on generated discharge. As mentioned earlier, microplasma can have many applications, but must have a certain parameters to fulfill requirements. One of the most important is the energy of the individual components. The measure of the kinetic energy of the gas is typically described by its temperature. In the case of non-thermal plasma electrons have a different energy than the ions, which is, in turn, different for components of the neutral background. Another important parameter is the electron density. It describes how many free electrons are in a volume unit of microplasma. If these two parameters are at appropriate level, it is possible to produce microplasma, which even can be touched with bare hands.

Due to the unique properties, diagnostics of plasma of specific methods. For the characterization of the low temperature plasma, present at reduced pressure in the reactors, probes are used (for example Langmuir). These device cannot be used for measure the microplasma, because it would change their geometry and properties. In our research we will use mainly methods of optical emission spectroscopy. It is based on measurements of the light emitted by the discharge. Through its analysis, namely investigating what is the intensity emission at different wavelengths and the shape of peaks, it is possible to determine the properties of the microplasma. Additional information can be obtained from electrical measurements (voltage-current characteristics). In addition, there will be used special mathematical tools of the design of experiment methodology. It allows assess what factors affect the individual process parameters, and which ones are most important. As a result, more information about the physical and chemical phenomena occurring in microplasmas will be obtained.