

Extreme ultraviolet (EUV) is some kind of invisible light from a wavelength range between ultraviolet and X-rays. A single EUV photon can ionize any atom or molecule, hence, this radiation cannot propagate in air. For this reason the EUV radiation cannot be encountered in our environment. On the other hand such radiation is emitted by various stars, can propagate in vacuum and is common in Space. This radiation can induce various molecular processes in planetary upper atmospheres or interstellar clouds. Everybody could see very beautiful images of nebulas recorded by the Hubble telescope. Such nebulas contain atoms or molecules irradiated by the EUV or X-ray radiation which results in their excitation and emission of the visible light. Similar processes in atmospheres of planets, especially young planets are also assumed to be induced by the impacts of bodies entering the atmospheres and originating from the protoplanetary disk. In our atmosphere it can be seen as the “falling stars” connected with entering of the atmosphere by a small meteoroid. Low temperature plasmas induced in both cases together with the accompanying molecular processes can be simulated in laboratory.

For experiments concerning the EUV induced molecular processes, the intense EUV sources can be employed. There is variety of such sources including synchrotrons, free electron lasers, laser high harmonics or plasma sources. The latter sources of extremely high pulse energy were used in experiments concerning laboratory simulations of X-ray induced plasmas formed in binary star systems. The EUV plasma sources seem to be useful for simulations of the EUV induced molecular processes and the low temperature plasma formation in upper planetary atmospheres. In this project the corresponding experiments will be performed using laser produced plasma EUV sources. On the other hand laser pulses of high intensity can be used for simulation of an impact of a small body entering the upper atmosphere. In this case the laser pulse is focused into the chamber filled with a gaseous mixture and the laser spark is being created. This spark is a high or moderate temperature plasma that has a similar influence on the surrounding gas as the shockwave and other factors accompanying the entry of the small, high velocity body into an atmosphere.

Within this project, comparative studies of molecular processes, induced in both experimental configurations, will be performed. For investigation of the EUV induced plasmas and the resulting molecular processes, a special system for formation of the EUV beam will be prepared. The EUV beam will be focused onto a small portion of a gaseous mixture injected into the vacuum chamber. As a result low temperature plasma will be formed, molecules contained in the mixture will be fragmented and new molecules will be created from the resulting species. All the excited species will emit light that can be recorded using various spectrometers. Each molecule emits characteristic spectrum. Based on the recorded spectra newly formed molecules can be identified.

Similar measurements will be carried out for processes associated with the laser induced breakdown. In this case, however, an additional equipment, allowing for fast imaging of the resulting plasmas, will be necessary. Significant differences in formation of the low temperature plasmas are expected between these two experimental systems. Also the corresponding molecular processes should be different, formation of different molecular species is expected.

Except the above mentioned experimental investigations, formation of low temperature plasmas and molecular processes can be modeled. It is planned to perform numerical modeling of various processes and benchmark to the experimental data.