## Description for the general public

A relatively young branch of nanophotonics, magneto-plasmonics enjoys bright prospects of providing the possibility to conveniently control the efficacy of light-matter interaction in a non-invasive way with a high switching rate. Despite a number of empirical observations, the field of magneto-plasmonics lacks the deep understanding of the underlying physical processes connecting the magnetic and plasmonic, or photonic parts of the puzzle. As a result, the vast possibilities provided by merging of these two fields are not properly explored yet. In order to get a better insight into the interplay of photonics and magnetism, there is a call for the time-resolved studies, which could provide an additional means to disentangle the various contributions. Moreover, in the time-resolved experiments, the possibilities of the interplay can be investigated in a reciprocal manner, exciting either magnetic or plasmonic dynamical processes indirectly, thus highlighting the role of the magneto-plasmonic interaction. Moreover, for the completeness of the picture the development of a theoretical framework capable of accurately reproducing the ultrafast dynamics in the hybrid magneto-plasmonic structures is required.

The current project is aimed at the studying the excitation of surface plasmon polaritons in hybrid magneto-plasmonic periodic structures based on noble metals and magnetic dielectrics on the ultrafast timescale. Because of the bilateral role of the magneto-plasmonic coupling, fundamental problems related to both ultrafast magneto-optical and opto-magnetic effects are tackled, thus providing a footing for the plasmon-assisted excitation of the magnetization dynamics and magneto-induced surface plasmon excitation. The key point in the proposal is the ability of distinguishing the dynamics of the magnetic and non-magnetic surface plasmons, obtained via both linear and nonlinear-optical transient response.

The experimental research studies under this project include time-resolved studies of the magneto-optical Kerr and Faraday effects in the conditions when different surface plasmons are excited. Further, surface plasmon dynamics at different interfaces will be studied under the excitation of the coherent magnetization precession with a circularly polarized light via the inverse Faraday effect and the photomagnetic effect. The analysis of the timescales in these multiple cases will be complimented by the theoretical modeling of the two-temperature model with the laser pulse as an energy source. Time-resolved nonlinear-optical studies of the surface plasmon dynamics will help to disentangle the role of the interfaces and the timescale of the interplay between the surface plasmons excited simultaneously at different interfaces of the metallic film.