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Acousto-magneto-plasmonics: a platform for the next generation ultrafast nano-photonic devices

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Acousto-magneto-plasmonics deals with experimental and theoretical investigations of interactions between the acoustic, magnetic and plasmonic transients in hybrid metal-ferromagnet multilayer structures excited by ultrashort laser pulses. The main focus is on understanding the novel aspects of acoustic dynamics in materials as well as the peculiarities in the nonlinear optical and magneto-optical response in nanoscaled structures. For example, the nonlinear optical detection is illustrated in details by probing the static magneto-optical second harmonic generation in gold-cobalt-silver trilayer structures in Kretschmann geometry. Furthermore, we show experimentally how the nonlinear reshaping of giant ultrashort acoustic pulses propagating in gold can be quantified by time-resolved plasmonic interferometry and how these ultrashort optical pulses dynamically modulate the optical nonlinearities. An effective medium approximation for the optical properties of hybrid multilayers enables the understanding of novel optical detection techniques. Exploring acousto-magneto-plasmonic functionalities at the nano-scale provide the experimental platform for designing the next-generation ultrafast nanophotonic devices. As the next step, functionalizing hybrid metal-ferromagnet multilayer structures with solid-state nano-scale light emitters will allow for detailed quantum-optical studies of magneto-plasmonic interactions at the nano-scale using nonlinear optical and quantum-optical techniques. From an even more fundamental perspective, combining graphene-based plasmonic nanostructures with optical metamaterials may shade light on the mysteries of topological plasmonics.

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