Preface

From medieval stained glass windows toward all-optical computer chips, an understanding of the interaction of light with a complex dielectric medium has been a key to designing and tailoring the optical properties of photonic devices.

For many centuries, the presence of metal nanoparticles has been evident because of the unusual colour effects associated with them. The red and yellow colours of many medieval church windows originated from silver, gold, and copper nanoparticles embedded in the window glass. The first evidence of using gold nanoparticles in antiquity dates back to the fourth century AD (the Lycurgus Cup). The physics of the processes remained a mystery until Michael Faraday, the well-known nineteenth century physicist, discovered that this effect is due to a new type of optical absorption in metal particles with dimensions substantially less than the wavelength of light.

Metal particles with sizes of the order of one to several hundreds of nanometres are the subject of intensive research efforts across the world. This is due to the fascinating differences in the optical properties they exhibit compared to bulk metals. When a metal particle is smaller than the wavelength of light, the light reflected from it is replaced by light scattering, which is particularly strong at the resonance frequencies of collective electron excitations in the particle. These oscillations are known as the particle's plasmons or surface plasmon resonances (SPRs). For noble and alkali metals, where the conduction electrons are sufficiently free-electron-like, the collective excitations show themselves as pronounced resonance effects in optical scattering and absorption spectra.

Glasses containing embedded metallic nanoparticles exhibit very promising linear and nonlinear optical properties, mainly due to the SPRs of the nanoparticles. The focus of this brief will be on the interaction of intense ultra-short laser pulses with glass nanocomposites comprising silver nanoparticles embedded in soda-lime glass, and nanostructural modifications in metal–glass nanocomposites induced by such laser pulses. In order to provide a comprehensive physical picture of the processes leading to laser-induced persistent shape transformation of the nanoparticles, series of experimental results investigating the dependences of laser-assisted shape modifications of nanoparticles with laser pulse intensity, excitation wavelength, and temperature are considered. In addition, the resulting local optical dichroism allows production of very flexibly polarizing optical (sub-)

microstructures with well-specified optical properties. The achieved considerable progress towards technological application of this technique, in particular for long-term optical data storage, will also be discussed. It is argued that the latter could be utilized for multi-bit encoding in spot sizes down to the diffraction limit, where the information can be read out very fast by wavelength- and polarization-sensitive detection of the transmitted light. The storage capacity of the proposed technique is comparable with that of Blu-ray disks.

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Stalmashonak, A.; Seifert, G.; Abdolvand, A.
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