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Editorial

Light–matter interactions at the nanoscale

Guest editors

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Optics at the nanoscale and specifically the interaction of light and matter at the nanoscale is a topic of rapidly increasing scientific importance and technological relevance. Nanoscale light–matter interactions are essential for the efficient conversion of light into chemical energy in biological light harvesting systems and for the light-to-current conversion in artificial photovoltaic devices. These interactions define the quite amazing linear and especially nonlinear optical properties of metallic nanostructures and hence are the key to understand and manipulate the nanoscale localization of light in the form of surface plasmon (SP) excitations. Such light localization phenomena are finding an ever-increasing number of fundamentally relevant applications ranging from cancer therapy and water splitting or photocatalysis in general to single molecule (bio-)sensing. When illuminating metallic nanostructures with ultrashort, femtosecond light pulses, local field intensities are easily reached that are sufficient to generate high harmonic radiation or to propel electrons out of these particles, generating new nanoscale sources of femtosecond electron bunches of potential interest for future applications in ultrahigh time resolution electron microscopy or diffraction.

Hybrid nanostructures, comprising metals, semiconductors and/or molecular aggregates may find entirely new applications in ultrafast switching or for designing new classes of photonic transistors with unprecedented sensitivity. Electronic spin excitations of nitrogen vacancies in diamond nanoparticles are exquisitely sensitive magnetic sensors and interesting as quantum bits in future information processing. When depositing metallic nanostructures on polymer films, SP excitation can result in local photopolymerization and this may be used for probing optical near-fields or studying photochemistry on the nanoscale. All these and numerous other emerging applications of nanoscale optics call for a broad overview of the ongoing research in this fascinating field.

It is the aim of this special issue on light–matter interactions to provide the overview of the field.

For this, we have assembled a series of 25 articles from leading researchers in this field.

This special issue starts with a tutorial on linear optical properties of aperiodic plasmonic crystals by C Bauer and H Giessen [1] and comprises three review papers and 21 original articles. The tutorial is followed by a review article on plasmon-based photopolymerization and its applications in near-field sensing and photochemistry [2]. Giugni *et al* [3] present an interesting review on the basics and applications of 'adiabatic nanofocusing', i.e., the transformation of propagating SP polaritons into nanometer-localized SP on, e.g., conical metal tapers. The third review, still in press, by Peruch *et al* [4] discusses the optical properties of ultrafast all-optical switches based on arrays of metallic nanorods.

The original articles in this special issue cover the following variety of topics:

(i) electromagnetic field distributions and linear optical properties of plasmonic nanostructures [5–9];
(ii) metamaterials [10];
(iii) ultrafast and nonlinear response of plasmonic materials [11–15];
(iv) energy transfer in nanosystems [16];
(v) coupling of SPs to quantum emitters [17–22];

(vi) quantum plasmonics [23];
(vii) casimir forces [24]; and
(viii) plasmonic optical tweezers [25].

All these topics reflect areas of very active current research in nano-optics and their breadth illustrates the fundamental and multifaceted relevance of light–matter interactions on the nanoscale.

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