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Editorial

Special Issue on Advances in Dielectric Photonic Devices and Systems beyond the Visible

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The impressive advances in dielectric photonics, integrated optics, and optical fiber-based systems are paving the way for increasingly challenging applications in wide research areas. Disruptive results in biomedicine, medical diagnostics, and therapy have been obtained via bio-photonics, e.g., by exploiting antibacterial agents in photodynamic therapy, bio-glasses synthesis, and the interaction of light with biological tissues.

Microstructures and nanoparticles included in glass are exploited by optical fibers and planar optics devices, in addition to photonic crystals and gratings, to obtain high-performance sensing. The improvement of sensor performances can be obtained by constructing periodic pillar arrays by covering the dielectric structure with thin metal layers and exploiting plasmon propagation or resonances. Novel materials, such as graphene, promise high-impact applications in microwaves, for the construction of phase shifters to optics, e.g., for obtaining absorbers.

As a direct consequence of the abovementioned advances in photonics, optical amplification and optical communication are important to obtain efficient optical signal transport and to fully exploit the information of all optical systems.

This Special Issue collects seven original contributions and one review paper on the abovementioned topics, including optical devices and systems beyond the visible, which cover a wide area of interest ranging from sensing and biomedicine to telecommunication.

Concerning bio-photonics, in [1], new derivatives of zirconium (IV) phthalocyanine (ZrPc) complexes linked to graphite oxide flakes have been considered. The optical properties, i.e., absorption and photoluminescence spectra, of ZrPcs and the composites are examined. Broadband red–near-infrared lamp is exploited to activate ZrPcs and the composites. Modified activity levels toward different bacterial strains are discussed, showing the potential of merging optic technology and medical expertise.

Optical biosensing and time-dependent monitoring of nanoparticle-biofluid interactions via Modulated 3D Cross-Correlation Dynamic Light Scattering have been described in [2]. In particular, paper [2] reviews dynamic light scattering (DLS) of gold nanoparticle–protein interactions for the model protein bovine serum albumin (BSA), as well as in complex biofluids. The paper illustrates that it is possible to differentiate rotational and translational motion, as well as agglomerate formation. Moreover, time-dependent monitoring of protein–nanorod interactions and monitoring of serum, with the use of nanoparticles, permits the detection of either the change of hydrodynamic radii of the components of the particles or of monitoring nanoparticle motion in the presence of serum.

In general, high-performance sensing is strongly required in robotics, aerospace, automotive, and industrial material processing. In [3], two-dimensional (2D) arrays of polymethyl-methacrylate (PMMA) nano-pillars deposited on Metallo-Dielectric Films are proposed by the authors to fabricate the periodic array enabling the phase-matching of the incident plane wave, thus exciting suitable optical resonances. These mechanically stable nano-pillars promise to be fully exploited for the fabrication of novel Metallo-Dielectric core/shell structures for sensing, surface-enhanced Raman spectroscopy, and light–matter interactions. Similar periodic structures can be constructed on graphene layers, obtaining a different behavior. In [4], two-dimensional dielectric gratings were proposed to achieve high absorption in monolayer graphene at visible and near-infrared frequencies. The dielectric gratings are employed to couple light with the graphene layer.

A novel sensing technique is proposed in [5], where Fiber Bragg Grating (FBG) sensors in a high-scattering optical fiber doped with MgO nanoparticles are proposed for polarization-dependent temperature sensing. The paper depicts how the inscription of high-reflectivity FBGs onto a fiber core doped with nanoparticles obtains reflectors into a fiber with Rayleigh scattering properties which can be suitably handled. Optical sensing is mainly investigated in the Near-Infrared (NIR) wavelength range, even if the Medium-Infrared (Mid-IR) wavelength range could be more useful in specific applications, since most biomolecules and atmosphere contaminants exhibit their fingerprints and can be detected more efficiently. In [6], a Mid-IR spontaneous emission fiber source, operating from 3.5 to 8 μm wavelength, is proposed for the first time, providing the output power at the mW level. The Mid-IR spontaneous emission fiber sources are an alternative to broadband Mid-IR supercontinuum fiber sources, both in complexity and cost. The interest towards this emission wavelength range is significant for molecular sensing applications across biology and chemistry, in medicine, agriculture, defense, and environmental monitoring.

The need for high-capacity communication networks is strictly related to the progress in optic and photonics to efficiently exploit the information delivered by the optical sensing circuitry. In [7], a dual-polarization quadrature phase-shift-keying (DP-QPSK) non-coherent reception scheme based on a delay-line interferometer (DLI) is proposed to improve the reception performance. A suitable data recovery algorithm is optimized for DLI-based DP-QPSK demodulation. In [8], the main objective of the study is to minimize the optical communication node resources, such as transponders, multiplexers, and wavelength selective switches, to provide and maintain high-quality dense wavelength division multiplexed (DWDM) network services by using a new generation of optical nodes. The data traffic-congestion problems arising in the context of both reconfigurable optical add-drop multiplexer technologies are investigated, showing interesting numerical tests carried out for realistic networks of different dimensions and traffic demand sets.

To conclude, the eight papers reported in this Applied Sciences Special Issue provide excellent examples of the current progress in the area of Dielectric Photonic Devices and Systems technology. There is information regarding new materials and components, sensing applications, and optical communication.

Conflicts of Interest: The authors declare no conflict of interest.

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