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Editorial

Plasmonic Coatings

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Thin films and nanoscale-sized materials used as functional coatings with plasmonic properties have contributed to the development of modern and innovative optical, photonic, energy conversion, and sensing devices [1–3].

Starting from the classical case of the exploitation of the plasmonic properties of Ag and Au, the use of plasmonic nanostructures has acquired increasing relevance and interest due to the occurrence of localized surface plasmon resonances (LSPRs) [4–8]. This phenomenon is based on the interaction of electromagnetic radiation with the conduction electrons of metallic nanoparticles. In fact, the incident photons excite the collective oscillations of the conduction electrons at the surface of the nanoparticles when their size is smaller than the radiation wavelength. The LSPR arises from the matching of the frequency of the incident radiation and the natural frequency of the collective oscillating electrons. This phenomenon can be exploited in several processes on which innovative devices are based. For example, the interaction of solar light with the conduction electrons of Ag and Au nanoscale-sized materials through LSPRs can lead to improved light-trapping in photovoltaic devices [9] and, hence, to enhanced free carrier generation. On the other hand, the local enhancement of the electromagnetic field, through LSPRs, near the surface of the plasmonic nanostructures (and leading to the so-called "hot spots") can enhance, by orders of magnitude, the intensity of the Raman spectrum of selected molecules [10,11], increasing the possibility of fabricating ultra-precise sensing devices.

However, in addition to metallic thin films and metallic nanostructures, coatings fabricated by specifically designed metamaterials, hyperbolic and negative refractive index materials, etc. that present a tunable plasmonic response are also attracting wide scientific and technological interest [1–4,12]. In general, the fine control of the nanoscale structure of matter allows for the tuning of the physical response of devices [7,8,13]. This is particularly true for the properties of plasmonic coatings. In this case, the size, shape, composition, and structure of the plasmonic systems (such as metal nanostructures and metamaterials) strictly determine the LSPR characteristics (such as the occurring frequencies); hence, the strict control of such a set of parameters is of paramount importance in view of the technological applications [1–4]. In order to achieve complete control, a strict combination of computational and experimental analysis is of fundamental importance for the final real application, in addition to a detailed understanding of the underlying microscopic mechanisms and parameters. The development of simple, versatile, low-cost, high-throughput nano-fabrication and nano-modification approaches is also highly relevant.

In this context, this Special Issue aimed to publish a series of illustrative examples on both theoretical and experimental scientific research regarding fundamental aspects and interdisciplinary applications of plasmonic coatings that describe the following: (a) the latest developments in nanofabrication methods for next-generation plasmonic coatings; (b) the development of new architectures for plasmonic coatings with specific functionalities; (c) the use of advanced state-of-art characterization techniques for the complete understanding of the properties of plasmonic coatings; (d) exploitation of the physico-chemical properties of plasmonic coatings in prototypes of devices (from sensors to solar cells).

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In particular, the topics included the following:

- Next-generation nanofabrication approaches for plasmonic coatings (metamaterials, metal nanostructures, single or stacking layers, etc.);
- Characterizations of plasmonic coatings;
- Theoretical modeling and design for next-generation plasmonic coatings;
- Plasmonic-film nanostructures;
- Novel plasmonic materials, including metallic alloys, complex-shape metal nanocrystals, polymer–metal nanocomposites, etc.;
- Three-dimensional plasmonic architectures;
- Broadband antireflection coatings;
- Applications of plasmonic coatings, including sensors and biosensors, surface enhanced Raman spectroscopy, solar cells, waveguides, etc.;
- Multi-plasmonics with periodically non-homogeneous thin films.

As an example, the paper published in this Special Issue titled "A Rapid Surface-Enhanced Raman Scattering (SERS) Method for Pb^{2+} Detection Using L-Cysteine-Modified Ag-Coated Au Nanoparticles with Core–Shell Nanostructure" by Xu et al. [14] reported a rapid surface-enhanced Raman scattering (SERS) method for Pb^{2+} detection, developed based on l-cysteine-modified Ag-coated Au nanoparticles with a core-shell nanostructure. The proposed SERS-based method shows a linear range between 5 pM and 10 nM, with an unprecedented limit of detection (LOD) of 1 pM for Pb^{2+}; this LOD shows the method to be a few orders of magnitude more sensitive than the typical colorimetric approach that is based on the aggregation of noble metal nanoparticles. Real water samples diluted with pure water have been successfully analyzed. This SERS-based assay may provide a general and simple approach for the detection of other metal ions of interest, and so could have wide-ranging applications in many areas. Another example concerns the paper "Photoluminescent and Photocatalytic Properties of Eu^{3+}-Doped MgAl Oxide Coatings Formed by Plasma Electrolytic Oxidation of AZ31 Magnesium Alloy" by Stojadinović [15], which reported the synthesis of Eu^{3+}-doped MgAl oxide coatings that contained MgO and $MgAl_2O_4$ through plasma electrolytic oxidation of AZ31 magnesium alloys in aluminate electrolytes, with the addition of Eu_2O_3 particles in various concentrations. The authors investigated their morphological, structural, and above all, photoluminescent (PL) and photocatalytic activity.

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