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Novel Optical Materials and Applications (NOMA): feature issue introduction

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Abstract: We introduce the *Optical Materials Express* feature issue on Novel Optical Materials and Applications (NOMA). This issue comprises a collection of fifteen papers that highlight recent progress in the design, fabrication, characterization, and theoretical analysis of advanced optical materials and photonic structures. This feature issue is built upon the 2024 Novel Optical Materials and Applications (NOMA) Conference, part of the Optica Advanced Photonics Congress that was held in Québec City, Québec, Canada in 2024.

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1. Introduction

The field of novel optical materials continues to evolve rapidly, driven by the increasing demand for compact, efficient, and tunable devices for next-generation communication, sensing, and energy technologies. As the focus shifts from traditional bulk optics to flat, integrated, and hybrid platforms, innovations in material synthesis, assembly and patterning, nanofabrication, and optical modeling are essential. This feature issue, consisting of 6 invited and 8 contributed papers and one invited opinion article, aims to showcase and highlight cutting-edge research that introduces novel materials and demonstrates their real-world applicability in photonic systems.

2. Summary of feature issue papers

Advances in optical materials increasingly stem from nanostructures and metasurfaces designed to manipulate light at subwavelength scales. Juneja et al. showed augmented fluorescence emission via the Purcell effect by incorporating fluorescent dye BP405 into photonic crystals based on diatoms [1]. Chen et al. proposed and demonstrated a novel ultra-thin metalens design using photonic-crystal slab resonance modes that are based on amorphous silicon on quartz [2]. Paul et al. demonstrated the potential of iridium- and iridium/alumina-based atomic-scale heterostructures as nonlinear optical materials [3]. Keller et al. explored the potential of synthetic Pockels-effect materials based on nonlinearities arising from intersubband transitions, which can be used for efficient plasmonic electro-optic modulators [4]. Ali et al. used numerical simulations to design a perovskite solar-cell with a triple-cation mixed-halide absorber and show that adding a back-surface-field layer boosts efficiency [5]. Aftab et al. studied the shrinkage in photopolymerizable hybrid sol-gel by examining the properties of volume transmission gratings, which demonstrate the potential for the development of holographic optical elements [6]. Kinsey et al. presented an opinion paper, building intuition for nonlinear index modulation in Drude-like epsilon-near-zero (ENZ) films and highlighted the physical limits of index tuning [7]. Adanan et al. investigated the tunable optical properties of Sb_2Te_3 and demonstrated its potential

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for continuous tuning from metal-like to dielectric behavior [8]. Shang et al. reviewed the fundamental mechanisms underpinning plasmon-photon coupling, focusing on localized surface plasmon resonance (LSPR), surface plasmon polaritons (SPPs), and hybrid photonic modes [9].

Applications of novel optical materials highlighted in this issue push the boundaries of optical fabrication, experimental demonstration, and computational optimization. Yin et al. leveraged the temperature dependence of vibrational modes of materials to facilitate accurate fitting of ellipsometry data, which can be used for modeling of absorbers, thermal emitters, and other infrared photonic structures [10]. Hinum-Wagner et al. applied a full-factorial design of experiments combined with regression trees to identify the layer-specific origins of propagation and bend excess losses in silicon-nitride waveguides [11]. Topper et al. fabricated novel optical fibers by employing the molten-core fabrication method with a potassium-niobium-germinate core glass and a Duran borosilicate cladding [12]. Grant et al. proposed a method based on ultra-high-vacuum chemical vapor deposition (UHV-CVD) to study growth dynamics of GeSn, employing an in-situ optical system, which is capable of monitoring the formation of Sn droplets in real-time [13]. Otieno et al. demonstrated high-precision femtosecond laser polishing of fused silica using gigahertz burst configurations, achieving an ultrafast laser fabrication method on the nanometer scale [14]. Khadka et al. presented precision control of uniform laser-induced periodic surface structures by manipulating the angle of incidence and polarization of the processing beam [15].

3. Conclusion

It is our hope that this feature issue offers a broad sample of emerging trends in optical materials and their applications, spanning topics from advanced material fabrication to nanoscale light manipulation. Research in these and other areas continues to be highlighted at the NOMA Conferences that are held each summer as part of the Optica Advanced Photonics Congress. We thank the contributing authors for their valuable insights and hope this collection will inspire continued innovation at the interface of materials science and photonic engineering. The editorial team would also like to thank the anonymous reviewers for making this issue possible, as well as the support of Dr. Stavroula Foteinopoulou for this feature issue and the Optica staff for their efforts throughout the review and production processes.

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