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***Nonlinear Frequency Generation
and Conversion: Materials, Devices,
and Applications X***

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Introduction

The span of electromagnetic frequencies, which can be achieved by means of nonlinear optics is impressive—more than four orders of magnitude: from the UV to THz—and this is reflected by a remarkable variety of current achievements in nonlinear optics presented in this volume.

In the realm of visible and UV generation, most hot topics are producing green, yellow and red colors by frequency conversion of the radiation of semiconductor lasers, the latter being known as efficient and inexpensive sources of near-infrared photons. For example, multi-watt orange light was generated by intracavity frequency doubling in a dual-gain quantum dot semiconductor disk laser (paper [7917-1]) and 1 Watt at 531 nm was generated in a ppMgO:LN planar waveguide by means of frequency doubling of a distributed Bragg reflector (DBR) tapered diode laser [7917-2]. Also, fiber-laser-pumped CW optical parametric oscillator (OPO) was shown to produce red, green, and blue laser light—all in one device [7917-5]. Vacuum UV light was produced at 193 nm by frequency conversion in quasi-phase-matched crystalline quartz that utilizes stress-induced twinning [7917-8].

On the other end of the spectrum, intense ultra-broadband (0.1 to 140 THz) terahertz waves with the field amplitude exceeding 100 MV/cm were produced via optical method using a hybrid Er:fiber-Ti:sapphire laser system. These pulses might be suitable for sub-cycle nonlinear optics [7917-11]. It has been demonstrated that ionized air plasma can be used as an emitter and a sensor for both generation and detection of broadband THz waves. In the case of THz generation, intense THz waves (peak THz field > 1.5 MV/cm) with a broadband spectrum, from 0.1 THz to 46 THz, were produced [7917-15]. Ultrasensitive room-temperature THz detection using parametric up conversion with a pulsed 1550-nm optical source was described in paper [7917-36].

In the field of ultrafast nonlinear devices, "light bullets" - Airy-Bessel wave packets which can be regarded as three-dimensionally localized light waves that do not spread in time or space as they propagate were reported and their applications highlighted [7917-26].

A new approach for generating ultra-broadband mid-infrared frequency combs in the difficult-to-access mid-infrared spectral region was implemented, based on degenerate (frequency-divide-by-two) optical parametric oscillation. This technique efficiently transfers the desirable properties of shorter wavelength mode-locked sources to the mid-infrared [7917-43].

As for new nonlinear optical materials, mid-infrared photonics based on silicon waveguides has been proposed. Low-loss (~ 4 dB/cm) waveguides appear to be

suitable for microresonators operating at wavelengths around $5.5\text{ }\mu\text{m}$, which can be used for sensing and nonlinear optics [7917-46]. In another paper, a new mixed LiGaInSe nonlinear optical crystal for the mid-IR was reported [7917-56]. Future directions in quasi-phase matched (QPM) semiconductors for mid-infrared lasers were highlighted and the properties, processing, and performance of orientation patterned GaAs (as a typical example of semiconductor QPM material) were compared to those of the next generation materials. In particular, gallium phosphide (GaP) was identified as the most promising material for near-term development [7917-50].

In short, the future of nonlinear optics looks bright. Laser outputs are converted to new wavelengths, from vacuum UV (or even XUV) to THz and sub-THz with time formats varying from continuous-wave operation to attosecond pulse regimes.

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