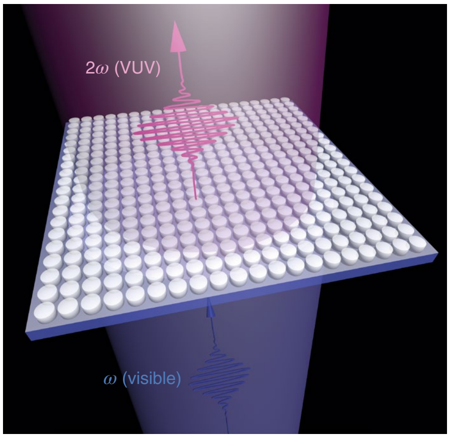
METAMATERIALS

Vacuum-ultraviolet source

Nano Lett. **18**, 5738–5743 (2018)



Credit: American Chemical Society

Ultraviolet light with wavelengths in the 100–200 nm range (known as the vacuum ultraviolet; VUV) has applications in nanofabrication, photochemistry and spectroscopy, to name just a few areas. At present, VUV light is typically generated by nonlinear processes in gases, which is not the most convenient or easily integrated approach. Now, Michael Semmlinger and colleagues in the US and Taiwan have demonstrated an all-dielectric metasurface that generates 197-nm light by resonantly enhanced second-harmonic generation. The structure is a periodic array of dielectric resonators fabricated by sputtering a 150-nm-thick layer of ZnO and patterning it by focused-ion-beam lithography. The resonator array was designed with a magnetic dipole resonance at 394-nm wavelength and provides an average effective nonlinear coefficient of 0.96 pm V^{-1} for pump powers below 0.2 mW that declines to 0.66 pm V^{-1} for higher pump powers. This is several times higher than an unstructured ZnO thin film (~0.20 pm V^{-1}) and double that of potassium fluoroboratoberyllate (KBBF). At present, the substrate is glass, which absorbs VUV; the effective nonlinear coefficient may actually be higher if a different substrate material is used. *DFPP*

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PHOTODETECTORS

Visible to THz

Sci. Adv. **4**, eaao3057 (2018)

The realization of efficient and economical detectors that are sufficiently broadband to span the visible, infrared and terahertz (THz) wavelength regimes would be appealing. Now, Dong Wu and a team in China have made a detector from 1T-TaS_2 (a 2D transition metal chalcogenide), which is responsive across this spectral range. And, it operates at room temperature. Unlike typical semiconductors, the 1T-TaS_2 crystal, which consists of planes of hexagonally arranged tantalum atoms between two layers of sulfur atoms, exhibits strong reflectivity at low energy. The team made single crystals by chemical vapour transport in a sealed quartz tube; the process requires a quenching process to retain the 1T phase. Several-micrometre-thick exfoliated flakes had gold electrodes deposited on them and 780-μm-long (23-μm-wide) channels cut into them before transfer onto a sapphire substrate. The researchers claim that the detector's 0.76 A W^{-1} responsivity at the THz wavelength of 118.8 μm is about two orders of magnitude better than that achieved with graphene-based broadband systems. *DFPP*

https://doi.org/10.1038/s41566-018-0271-8

MID-INFRARED PHOTONICS

Interband cascade laser

Optica **5**, 996–1005 (2018)

When it comes to mid-infrared sources, interband cascade lasers (ICLs) that operate in the mid-infrared band are of interest because they potentially have thresholds for operation that are 1–2 orders of magnitude below quantum cascade lasers (QCLs). Now, scientists in the US have managed to integrate III–V ICLs with silicon waveguides, leading the way to silicon-based photonic integrated circuits for applications in the mid-infrared. The ICLs operate at a wavelength of 3.65 μm and in pulsed mode. The threshold current density of the devices varies with temperature, ranging from ~0.3 kA cm^{-2} at –100 °C to ~2 kA cm^{-2} at +50 °C. Output powers are in the range of 1–12 mW. The integration is achieved by using a hydrophilic plasma-assisted bonding process to bond a III–V epilayer that forms the active region of the ICL to silicon. The researchers believe that with further optimization of the design and fabrication, continuous-wave operation should be possible in the future. *OG*

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X-RAY PHOTONICS

Watching plasma birth

Phys. Rev. X **8**, 031034 (2018)

Exactly what happens when an intense pulse from an X-ray free-electron laser (FEL) strikes a nanoscale target has now been revealed by an international collaboration of scientists from Japan, Finland, Estonia, France, Romania, Germany and China. It is well known that a plasma is formed, but the timescale and details of its birth and evolution have to date remained hidden, largely because of the temporal jitters on the order of 1 ps that exist between the XFEL pump pulses that creates the plasma and the near-infrared (NIR) probe pulses that are used to investigate it. Now, this issue has been overcome and scientists have succeeded in monitoring the birth of a nanoplasma formation in Xe clusters. The experiments were performed at the XFEL facility in Japan, SACLA, using 5.5-keV X-ray pulses with a bandwidth of 40 eV, duration of less than 10 fs and a peak fluence of 30 μJ $μm^{-2}$, and NIR pulses (central wavelength of 800 nm and pulse duration of 32 fs) with a peak fluence of 15 nJ $μm^{-2}$. The experiments show that the plasma formation is accompanied by the generation of excited states, with an ultrafast population (~12 fs) followed by a slower depopulation (~250 fs) of excited states. *NH*

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LASERS

Supressing instability

Science https://doi.org/gd3p56 (2018)

Spatiotemporal instabilities in broad-area high-power semiconductor lasers are troublesome and unwanted as they degrade laser performance. However, eliminating them is difficult. A team of scientists from the US, UK and Singapore has now discovered that such instabilities can be strongly supressed by the use of either D-shaped cavities that support chaotic ray dynamics or resonators that feature random refractive index fluctuations. In both cases, the formation of filament-type instabilities is prevented by interference between many waves with random phases and stable multimode lasing occurs. Such stable lasers could prove useful for applications such as materials processing or as high-power pump sources for fibre lasers and amplifiers. The research team says that the concept should also be applicable to other forms of lasers such as broad-area vertical-cavity surface-emitting lasers (VCSELs) and solid-state lasers. *OG*

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