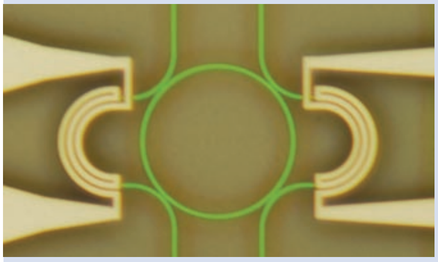
SILICON PHOTONICS

Tiny and tunable



Opt. Lett. **32,** 3361–3363 (2007)

Long Chen and colleagues at Cornell University have come up with a new design of microring resonator that is both compact and bandwidth-tunable. The device could be useful for applications involving optical communication and information processing. In integrated optical signal processing, for example, reconfigurable channel selectors tune the bandwidth of an add–drop filter to accommodate one or more channels within a single resonance and enable easy switching between them.

The bandwidth of a resonator describes the range of wavelengths or frequencies over which its resonances exist. A narrow bandwidth is better suited to certain purposes (such as lasing and sensing), but for other applications a wide bandwidth is preferable. Resonator bandwidth is determined by the intrinsic loss and the coupling to input or output ports.

The Cornell team fabricated a microring resonator on a silicon-on-insulator substrate with a continuously tunable bandwidth of between 0.1 nm and 0.7 nm. The key to the tunability is the use of interferometric couplers that dynamically alter the coupling between the resonator and the input and output ports using thermo–optic effects. By tuning both the input and output coupling coefficients, the bandwidth can be varied while maintaining a high extinction ratio of more than 23 dB. This is all achieved in a device with a footprint of less than 0.001 mm^2. With improved coupling design and fabrication processing, the researchers say that a tuning range from 0.01 nm to a few nanometres will be possible.

LASER PROJECTION

The right image

Opt. Lett. **32,** 3281–3283 (2007)

Phase-only modulation is a promising technique for projecting images using laser light. Researchers in Denmark have now demonstrated that a technique known as generalized phase contrast can achieve this while wasting very little of the laser light.

One of the major challenges in phase-only modulation is to determine the particular phase pattern that yields the desired output intensity. In generalized phase contrast, a phase-modulated light beam is broken down into its Fourier components using a lens. A small non-absorbing phase-contrast filter is then used to shift the phase of the lowest frequency waves relative to the higher-frequency ones, and interference between the various recombined frequency components yields the desired intensity spectrum.

Jesper Glückstad and co-workers at the Technical University of Denmark use generalized phase contrast to construct a greyscale photographic image with an efficiency of 74%. By using an arbitrary phase-shift filter, they avoid the need for high-frequency modulation and conjugate-phase encoding, and can use existing dynamic spatial light modulators instead. As a result, the device performance needed to achieve the projection can be relaxed, which makes the scheme easier to implement in practice. This generalized-phase-contrast approach could benefit a range of applications that rely on efficient projection of laser beams, for example: laser imaging for the patterning of material surfaces; phase-only encryption and data storage in optical information systems; or light control in all-optical lab-on-a-chip devices.

HOLOGRAPHY

DNA stripes

Opt. Express **15,** 15268–15273 (2007)

The potential applications of DNA in photonics and molecular electronics are increasingly attracting attention. Although DNA itself is optically passive, a group of scientists from France and the USA have shown that adding functional groups to DNA creates a medium that can be inscribed by a holographic grating and may be useful for optical data storage.

The authors prepared a complex of DNA and CTMA — a surfactant that has previously been shown to improve the temperature resilience of the DNA's double-helical structure. The complex was then functionalized using DR1, a chromophore derived from azobenzene, and spun into a thin film. Two interfering laser-beam pulses were used to record a diffraction grating on the film and a continuous-wave laser was used to monitor the grating formation. Thin films of polymethylmethacrylate and poly(9-vinylcarbazole) were also functionalized with DR1 and similarly inscribed with a diffraction pattern for comparison.

Grating patterns were successfully inscribed on both the functionalized DNA–CTMA complex and polymethylmethacrylate. However the inscription process was fastest for the DNA–CTMA complex, which was also found to undergo observable relaxation when the inscribing pulses were removed. In addition the DNA–CTMA complex was most sensitive to the polarization of the inscribing beams; when the two inscribing beams had opposite polarizations, no diffraction pattern was observed.

The results indicate that DNA–CTMA has potential for applications in dynamic holography, a promising avenue for optical storage.

ATOMIC OPTICS

Moving in time

Phys. Rev. Lett. **99,** 213601 (2007)

Intense light can radically alter the optical properties of a material. It would be useful, however, to achieve the same optical phenomena at much lower field intensities, even at levels where only a few photons are present. Subhadeep Gupta and co-workers from the University of California, Berkeley, and the Lawrence Berkeley National Laboratory have now seen nonlinear optical effects using light with a photon number less than one.

To make a material's response to a weak optical field similar to the response to intense pulses, it is necessary to increase the strength of the interaction between light and matter. A tried and tested method for this is to use tiny optical cavities. Gupta *et al.* trap cold rubidium atoms inside a cavity and exploit coherent collective motion of the atoms to create optical nonlinearity. The optical force exerted by the photons is enough to displace the atoms, changing the effective refractive index of the system — so-called Kerr nonlinearity. The nonlinearity was observed by measuring the transmission of light as its wavelength is swept through the cavity resonance. The team