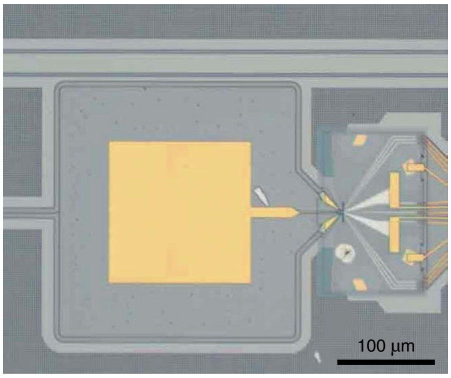
SPINTRONICS

Spin–photon coupling

Science **359**, 1123–1127 (2018)



Credit: AAAS

Exploiting the electron spin of silicon quantum dots is potentially useful for applications such as quantum information processing. However, such electron spins suffer from extremely small coupling with microwave photons. Now, Samkharadze and co-workers from the Netherlands and Canada have developed an on-chip system that supports strong spin–photon coupling. The idea is that the microwave photon is stored in an on-chip superconducting cavity resonator that is adjacent to a pair of SiGe/Si/SiGe quantum dots. The resonator is square shaped and formed by a thin NbTiN conductor. The impedance of the cavity resonator was about 1 kΩ to enhance the coupling to the quantum dot charge dipole and provide resilience against in-plane magnetic fields. When an electron oscillated between the two dots due to an external magnetic field, it experienced an oscillating transverse magnetic field, yielding indirect spin-charge hybridization that allows strong spin–photon coupling. The observation of vacuum Rabi splitting provided evidence for strong coupling between the spin and the microwave photon. The approach could provide a route to the creation of a large network of quantum-dot-based spin qubit registers. *NH*

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OPTICAL SENSORS

Monitoring mosquitoes

Appl. Phys. B **124**, 46 (2018)

According to the World Health Organization, mosquitoes are the greatest animal threat to human health, spreading diseases such as malaria, dengue, yellow fever and the Zika virus, which are collectively responsible for several million deaths every year. Mosquito distributions are closely monitored but methods often rely on human involvement. Now, Adrien Genoud and colleagues at the New Jersey Institute of Technology and Rutgers University in the United States, have developed an infrared optical remote sensing system for characterizing the gender and species of flying mosquitoes. The authors recorded 427 signals from a sample containing males and females of three different mosquito species. The authors attempted to use wing-beat frequency as a predictor for gender alone, as well as species and gender. A continuous-wave laser diode with 1,320-nm wavelength and 3.6 W power illuminated moquitoes 3–4 m away. InGaAs amplified photodetectors detected the light scattered as a mosquito transited the illumination; the modulation of the backscatter due to the insect body is easily separable from the faster (100 Hz to 1,000 Hz) wing beating. Using a Bayesian classification method, gender alone is discriminated with 96.5% accuracy. However, when gender and species are characterized, overall accuracy of classification drops to 62.3%. In real samples, even more species are likely to be present and additional (remotely measurable) variables, such as optical cross-section or depolarization ratio, may be needed to improve accuracy. *DFPP*

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LASERS

Powerful X-rays

Optica **5**, 257–262 (2018)

Large-scale free-electron laser and synchrotron facilities are excellent sources of high-energy X-rays. Meanwhile, smaller options, such as plasma-based X-ray lasers, enable smaller laboratory-scale facilities to conduct some experiments requiring relatively intense X-ray pulses. Now, Alex Rockwood and a team from Colorado State University and Oak Ridge National Laboratory have extended the wavelength range of compact gain-saturated X-ray lasers from around 9 nm, down to below 7 nm, by using an excited Ni-like Gd ion plasma formed by a combination of an optimized pre-pulse and a subpicosecond pump pulse. The pulses, from an 800-nm Ti:sapphire laser, irradiated 1–2 mm thick targets. First, the normal incidence 'pre-pulse' ionizes plasma to a Ni-like ionization regime, and the following subpicosecond pulse, at grazing incidence, heats the electrons and results in population inversion. In principle, different propagation velocities of the pump pulse and the amplified pulse limits amplification of the X-ray laser pulse, but the team was able to overcome this by using a reflection echelon with adjustable mirror segments, enabling adjustable excitation travelling wave velocity. The 6.85-nm Gd lasing was achieved with 2.5 Hz repetition. Even shorter lasing wavelengths were achieved, down to 5.85 nm, by using different Ni-like lanthanide ions and increasing pump pulse grazing incidence angle to yield higher plasma densities. *DFPP*

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X-RAY OPTICS

Tight focusing

Light Sci. Appl. **7**, 17162 (2018)

The ability to focus X-rays to spots on the nanometre scale is attractive for high-resolution analysis of a variety of samples. Now, Saša Bajt and co-workers have developed high numerical aperture (NA) diffractive optical elements called Laue lenses and have shown that they can focus 16.3 keV (0.077 nm wavelength) X-rays to a focal spot of 8.4 × 6.8 nm in size. The lenses operate in a similar manner to a Fresnel zone plate lens and consist of thousands of alternating layers of tungsten carbide and silicon carbide with varying periodicity. The team fabricated a pair of lenses, one for horizontal focusing and one for vertical focusing. The former was 21.8 µm in height and composed of 3,326 bilayers and had a focal length of 1.36 mm and a NA of 0.008. The latter was 29.9 µm high and consisted of 5,100 bilayers and had a focal length of 2.02 mm and a NA of 0.0074. The lenses were tested with X-ray beamlines at the PETRA III synchrotron facility at DESY in Germany and the National Synchrotron Light Source II at Brookhaven National Laboratory in the US. The researchers say that the approach offers a path to X-ray imaging with 1 nm resolution. *OG*

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Oliver Graydon, Noriaki Horiuchi and David F. P. Pile