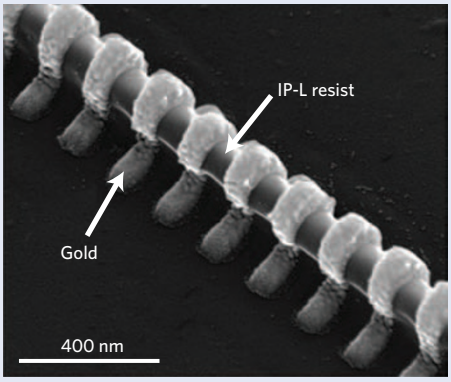
METALLIC NANOSTRUCTURES

Not so flat

Metallic nanostructures exhibiting unusual or naturally unobtainable optical properties can be fabricated by various techniques. Their feature sizes and complexity have advanced greatly over the past few years and the fabrication of bulk three-dimensional (3D) systems is fast becoming a reality. However, many highly controllable fabrication techniques are limited to working with layers of planar geometries as they typically involve some combination of thin-film deposition and 'top-down' lithography utilizing electron beams or focused ion beams. This tends to result in structures that lack strongly 3D features.

Now, Isabelle Staude and colleagues from the Australian National University (Canberra) and Swinburne University of Technology (Melbourne) have demonstrated a method capable of fabricating metallic nanostructures that are more three dimensional by combining the advantages of conventional electron-beam lithography and direct laser writing (*Adv. Mater.* DOI: 10.1002/adma.201203564). Their method exploits the 3D writing capability of direct laser writing to form larger 3D structures like rods, and the sub-100-nm feature sizes of electron-beam lithography to pattern deposited metals. The extra dimensionality of the achieved structures enabled the researchers to confirm a magnetic response from the samples. Their approach gives a sufficiently high resolution for near-infrared and visible light applications.



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Staude explained to *Nature Photonics* that the team was surprised how straightforward the technique is and that the very first fabrication test delivered a 3D structure. She noted, however, that it is not always easy to fabricate designed, optically functional structures to the required alignment precision. Also, to realize a reliable lift-off procedure, they found it necessary to use a thicker electron-beam resist (PMMA) than in their usual 2D protocol. However, the approach seems to be very robust and reliable.

"To be accessible with this approach, structures have to be a projection of a 2D pattern on a curved surface. For example, we cannot fabricate a helix, but we can form a tapered helix," Staude commented. "The resolution of the gold feature sizes is determined by the resolution of the electron-beam lithography process, which is well below 50 nm. The feature sizes of the 3D polymer template are limited by the resolution of direct laser writing. Line widths below 150 nm and centre-to-centre distances of 600 nm can be routinely achieved in the employed 'IP-L' resist. The team hopes that the proposed technique will enable the fabrication of 3D chiral metamaterials and antenna structures. It may also allow metallic nanostructures to be printed directly on top of other photonic components such as optical waveguides.

DAVID PILE

VIEW FROM... AIP/ACOFT 2012

Shifts down-under

AIP/ACOFT 2012 was last year's biggest and most diverse scientific meeting in the Australian physics calendar. Optics and photonics dominated; although traditional Australian strengths like quantum optics and X-ray science were well represented, there were some shifts to other fields.

David Pile

Just a 20-minute walk from the vibrant and photogenic Coogee beach area in Sydney, the University of New South Wales hosted the 20th Australian Institute of Physics (AIP) Congress on 9–13 December 2012. Co-located with the 37th Australian Conference on Optical Fibre Technology (ACOFT) organized by the Australian Optical Society and Engineers Australia, the meetings arguably represent the most important event in the Australian physics calendar, attracting prominent overseas attendees.

Attendees mainly came from universities, although government, commercial, industrial and education sectors were also represented. It would be fair to say that the field of optics and photonics dominated the meetings. However, one highlight of the meeting was a session dedicated to the historical aspects of physics, in which the University of Queensland was particularly well represented. Timo Nieminen gave a talk on radiation pressure, explaining the concept in terms of various branches of physics and reminding us how beautiful physics can be. Norman Heckenberg told the fascinating story, which included some serious sleuthing, of Thomas Murday's incredibly sensitive recording microbarometer made in 1912. The story started in the United Kingdom, came to fruition in Sydney, progressed to a junkyard elsewhere in the country, and finished at the University of Queensland's recently refurbished Physics Museum (www.smp.uq.edu.au/content/physics-museum).

Although academics dominated the meeting, it was encouraging to see industrial researchers tackling important practical problems. As one example, wafer alignment — a procedure performed between each wafer-processing step — is a critical issue for fabricating high-density circuits in silicon devices. Matthew