can be precisely tailored through plasmonic resonances and the coupling between them. To date, most nonlinear optical experiments have been performed with thin metasurfaces as these are much easier to fabricate on the nanoscale. For example, researchers have used metasurfaces to demonstrate the importance of symmetry at both the nanoparticle and array levels as well as to underline the challenges posed to nanofabrication by detrimental surface defects[16]. A notable exception is the use of a bulk zero-index metamaterial to address the issue of phase-matching in four-wave mixing processes[17]. Although, to be used for harmonic generation this concept would require a broadband zero-index metamaterial, which is still lacking.

Segal *et al.*[8] designed a plasmonic metasurface that operates in the near-infrared (at a wavelength of 1,200 nm) and is made of an array of tiny gold split-ring resonators (SRRs) on glass. When the SRRs are arranged in a uniform array, second-harmonic generation occurs for pump powers of 150 mW. To improve on that, SRRs were designed such that resonant modes at the fundamental and second harmonic have a different symmetry with respect to the SRR base. Then, flipping SRRs produces a periodic inversion of the effective quadratic nonlinear coefficient $\chi^{(2)}_{\text{eff}}$, just as in quasi-phase matched structures (see Fig. 1a,b). Segal *et al.*[8] then used these structures to demonstrate an improved control over nonlinear diffraction through one-dimensional and two-dimensional transverse phase matching. First, they experimentally verified that the mechanism at work in one-dimensional structures is Raman–Nath nonlinear diffraction, as predicted, and then they designed a two-dimensional binary-phase Fresnel zone plate. By arranging SRRs in concentric rings of different radii with alternating directions, they experimentally demonstrated a 73-fold enhancement in intensity compared with the metasurface itself (see Fig. 1c,d). Moreover, Segal and colleagues[8] theoretically explored the possibility of longitudinal quasi-phase matching, by stacking different metasurfaces along the direction of propagation, and demonstrated a greatly improved efficiency.

This work not only demonstrates that the approach of adopting quasi-phase matching on the nanoscale is highly effective but it is also likely to inspire the community for several reasons. First, researchers in plasmonics and photonic crystals now have easy access to numerous tools for periodic structures, both numerical and experimental, that should greatly aid research in the area. Second, the focusing capabilities of these structures should pave the way for low-power operation of integrated devices, such as frequency converters, all-optical switches and parametric amplifiers. Finally, the prospect of increased interaction lengths in longitudinally quasi-phase-matched metasurfaces, which still remains to be demonstrated experimentally, is highly attractive for realizing ultracompact, efficient nonlinear devices. Another more elusive possibility is integration of such nonlinear plasmonics into optical fibres. Indeed, on a larger scale, nonlinear photonic crystal fibres are already at the heart of revolutionary applications, such as supercontinuum generation, that have transformed spectroscopy.

Following these first demonstrations of the possibilities afforded by nonlinear plasmonic metamaterials, what is now needed to meaningfully impact integrated optics is a transition from free-space to fully integrated designs. If that can be accomplished, such materials will likely play a significant role in advancing the capabilities of photonic circuitry.

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Correction

In the Editorial 'A year to remember' (*Nature Photonics* **9,** 1; 2015), the acronym for finite-difference time-domain contained a typographical error and should have read FDTD. This has now been corrected in the online versions after print 22 January 2015.

Correction

In the News & Views 'Thought experiments made real' (*Nature Photonics* **9,** 76–77; 2015), in the Fig. 1 caption the equation describing the observation angles for constructive interference contained a typographical error and should have read $n\lambda = r\sin\theta$. This has now been corrected in the online versions after print 16 February 2015.