metasurfaces have been investigated for many applications. In his talk, Brongersma presented the application of metasurfaces as passive components, such as lenses, axicons and waveguide dispersion controllers, as well as active components and devices, such as beam-steering devices, spatial light modulators, light-trapping devices for solar cells and light-extraction devices for light-emitting diodes.

When asked by *Nature Photonics* if there is any restriction on materials that can be used to produce metasurfaces, Brongersma replied, "any materials out of which we can form resonant structures, including metals, semiconductors and oxides, can be used to make metasurfaces."

"I think metasurfaces will help reach the fundamental performance limits of devices, such as solar cells, light-emitting diodes and beam-steering devices. They will also enable conventional systems to become more compact, lightweight, easier to fabricate, and so on," Brongersma envisioned. However, he also raised the concern that the resonant properties of nanoscale building blocks are extremely sensitive to their size, shape, spatial arrangement and environment. Consequently, there will be significant nanofabrication challenges.

"For these essentially planar structures we can effectively unleash many powerful, existing fabrication routes; for example, complimentary metal–oxide semiconductor technology, nanoimprinting, photolithography and thin-film patterning," said Brongersma.

On the other hand, Yin gave a talk on the spin Hall effect of light in metasurfaces — a ubiquitous, but exceedingly weak optical effect. It arises from the interaction between a photon's spin degree of freedom and its orbital motion.

"In fact, this is also the basis of spintronics — a spinning electron and the trajectory of its motion. The only difference is that it is much stronger for electrons in spintronic materials than for light. A photon has a much smaller orbital angular momentum than an electron, as the momentum of a photon ($\hbar k$) is always smaller than its energy by a factor of the speed of light," Yin explained. According to him, the spin Hall effect is proportional to the curvature of the light trajectory; the sharper the bending curvature is, the stronger the effect. A judiciously designed metasurface with a phase singularity provides the highest curvature achievable for surfaces as thin as 30 nm, allowing a highly amplified spin Hall effect to be observed.

RACHEL WON

Figure 2 | This year's SPIE Optics and Photonics held in San Diego Convention Center attracted more than 4,500 attendees — 200 more than last year.

The spin Hall effect allows the conversion of spin and orbital angular momentum to be controlled. When asked about potential applications of the spin Hall effect in metasurfaces, Yin replied, "My personal opinion is that when we utilize any of these two parameters [spin or orbital angular momentum] as the information carrier (in fact, we have been using it for quantum information processing), the spin Hall effect will allow us to perform logical manipulation and computing with light's circular polarization and orbital angular momentum."

Just like in any other field, there are many challenges that need to be overcome before the spin Hall effect in metasurfaces can be exploited. According to Yin, minor challenges include how spin Hall devices can be implemented with integrated photonic approaches for device applications, and how the effect can be analysed theoretically or analytically, as the original theory is based on the adiabatic change of light momenta and the conservation of momentum of a light wave, which are not valid for metasurfaces.

"Grand challenges include introducing light–light interactions that are strong enough to make the spin Hall device optically actuatable so that it operates like a spin valve transistor. Will the coherence of light make a big difference so that spin Hall devices will achieve better performance and functionality than devices based on incoherent electrons?"

The most exciting thing about the planarization of optics is the possibility of designing new flat optical components — this could potentially have an impact as revolutionary as planar technology in electronics. Despite the many open questions, the intensive research being conducted in this area will undoubtedly result in many surprising results in the near future.

This year's SPIE O+P attracted more than 4,500 attendees, which is 5% more than last year, and featured 17 plenary talks and more than 3,300 technical presentations. Next year, it will be held on 17–21 August at the same venue. ❐

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Correction

In the Commentary entitled "Nanotube and graphene saturable absorbers for fibre lasers" (*Nature Photon.* **7,** 842–845; 2013), "electrical gating[24]" on page 844 should have been "electrical gating[25]", "compressed externally[19,34]" on page 845 should have been "compressed externally[13,34]" and "23. Davide Di Dio Cafiso, S. *Opt. Lett.* **38,** 1745–1747 (2013)" in the reference section should have been "23. Davide Di Dio Cafiso, S. *et al. Opt. Lett.* **38,** 1745–1747 (2013)". These errors have been corrected in both the HTML and PDF versions.