passing through the device is much shorter than the mechanical deformation period, the frequency of photons in the pulse shifts adiabatically (Fig. 1d). Since the frequency shift ($\delta\omega$) depends on the deformation amplitude (thus the RF signal amplitude), it can be dynamically controlled.

To implement the approach in a realistic experiment, Fan *et al.* designed and fabricated an AlN piezoelectric membrane waveguide integrated with two opposed RF electrodes as shown in Fig. 2a (see Fig. 3 in ref. 8 and Fig. 3 in ref. 9 for details). An advantage of the approach is that the membrane waveguide is deformed uniformly over its full length (here 6 mm). The membrane waveguide is supported by a series of miniature pedestals placed every 100 µm along its length to allow the desired vibration mode to have low loss and large amplitude.

To apply the RF electric field vertically, one electrode was patterned on an AlN/SiO_2 mesa as high as the AlN membrane waveguide and the other electrode was patterned lower down on the Si substrate (Fig. 2a). It's an impressive feat of nanophotonics engineering to create such a long waveguide beam that is supported only by a series of nanoscale pedestals. The authors' innovative design means that a high frequency modulation (here ~8.3 GHz) with a large amplitude could be realized. This yielded a successful demonstration of an optomechanically induced frequency shift of up to 150 GHz in a single-photon experiment and up to 180 GHz in an experiment in the classical regime. In addition, the realization of high visibility (~0.9) in two-photon quantum interference experiments is noteworthy.

In summary, by using optomechanics, Fan *et al.* have demonstrated adiabatic frequency conversion on a chip that only requires an input optical signal and a RF voltage. Their approach does not require an optical cavity and is compatible with quantum information technology. Since the research is still in its preliminary stage, there is considerable room to improve the performance in the future. For example, the present device structure does not appear to be optimized in terms of the voltage applied to the AlN membrane and further enhancements in the device's efficiency and frequency shift can be expected. ❒

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BIOPHOTONICS

Order in photosynthesis

Iridescence is displayed by many plants and other photosynthetic organisms, but the biological function of this eye-catching feature is not yet fully understood. A study by Matthew Jacobs and collaborators from the University of Bristol and the University of Essex in the UK now suggests a direct link between iridescence and photosynthesis. The team reported that the iridoplasts (a type of epidermal chloroplast; top right image) found in the blue iridescent leaves of some species of *Begonia* are characterized by photonic crystal structures responsible for selective light absorption and increased quantum yield in low-light conditions (*Nat. Plants* **2,** 16162; 2016).

The iridescent *Begonia* species grows in the tropical forest understorey, where light conditions for photosynthesis are rather extreme: indeed, overhead foliage and branches are responsible for light attenuation up to 60–70 dB and for significant light absorption around 460 nm and 680 nm. "From a plant science perspective, the interaction of photonics and photosynthesis is virtually unexplored, so there is lots of potential to understand and perhaps improve how plants deal with light," Jacobs told *Nature Photonics*.

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The authors used transmission and cryogenic scanning electron microscopy to observe the ultrastructure of individual iridoplasts (bottom right image), which consist of regularly spaced stacks, or grana, of smaller light-absorbing compartments known as thylakoids. To investigate the potential photosynthetic function of these highly ordered iridoplasts, Jacobs and co-workers developed an optical transfer matrix method model that indicated that the reflectance peak wavelength of a single iridoplast — typically around 470 nm — depends on the spacing between adjacent grana. Further data analysis showed that iridoplasts exhibit enhanced light absorption between 500 and 700 nm and a reduced absorbance below 500 nm, the cut-off wavelength again being determined by the spacing between grana. This response mirrors the light conditions of the forest understorey in that the observed enhancement in light absorption occurs for those wavelengths that are not filtered by higher foliage. As for the effect of this light management on photosynthetic processes, Jacobs and collaborators found that the quantum yield — the efficiency with which absorbed light can be used for electron transport and photosynthesis — in shade conditions is higher by 5 to 10% for iridoplasts than it is for other types of chloroplast.

When asked about potential applications beyond a plant science viewpoint, Jacobs said that "photonic structures similar to those found in iridoplasts are being investigated for use in solar energy devices. The iridoplast structure is interesting in this respect since the photonic structure and the light-harvesting structure are the same, and this idea could then inspire new light-harvesting applications." Future work will also look into photonic chloroplasts that are not iridescent.

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