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# Extreme twists of light in photonic crystal waveguides

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Highly accurate sensing of chiral molecules is crucial in drug development as one mirror image (enantiomer) of a chiral molecule can be toxic while the other mirror image can be healing. As the rate of absorption of a chiral molecule is different when illuminated with left-handed circularly polarized light (LCPL) than when illuminated with right-handed circularly polarized light (RCPL), this interaction asymmetry can be used to probe the chirality of molecules. Circular dichroism (CD) spectroscopy essentially relies on this interaction asymmetry though measured signals are typically very weak [1]. We propose to enhance this light-matter interaction using *superchiral* light with a fully dielectric structure that can be integrated with on-chip photonics. Here, light has an *optical chirality* (C) that exceeds that of circularly polarized light (CPL). Chiral plasmonic nanostructures were already demonstrated to have superchiral electromagnetic near fields and were used to sense chirality of molecules with enhanced sensitivity [2].

We demonstrate that the near field of conventional silicon photonic crystal waveguides (PhCWs) is locally superchiral as it contains values of C up to ten times larger than CPL ($C_{CPL}$=1) at specific locations, see Fig. 1(a). However, as can be seen in Fig. 1(a), the structure is fully symmetric resulting in *total* integrated C that is zero. Thus, actual sensing of a homogeneous ensemble of chiral molecules is impossible. Realization of a nonzero total C requires breaking of all mirror symmetries in the system. By shifting of air holes around the waveguide and addition of a glass substrate, an optimized geometry (Fig 1(b)) with nonzero total integrated C and local values of C larger than 24 was realized, opening a new route to nanoscale sensing of chiral molecules.

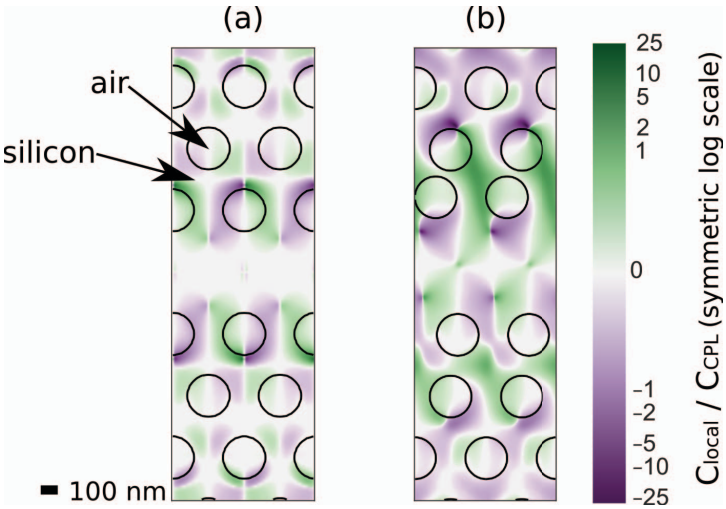


**Fig. 1** Optical chirality C of the electromagnetic field 20 nm above (a) a conventional photonic crystal waveguide and (b) C for a novel chiral photonic crystal waveguide for which all mirror symmetries are broken. In the field above the conventional chiral photonic crystal waveguide (a), values of C locally exceed 10 and for the chiral photonic crystal waveguide, values of C go as high as 24, meaning the optical chirality is 24 times larger than that of circularly polarized light.

## References

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