Radiationless anapole states in on-chip photonics

E. Díaz Escobar(1)
T. Bauer(2), E. Pinilla Cienfuegos(1), A.I. Barreda(1,3), A. Griol(1), L. Kuipers(2), A. Martínez(1)
(1) Nanophotonics Technology Center, Universitat Politècnica de València, Camino de Vera s/n, 46022 Valencia, Spain.
(2) Department of Quantum Nanoscience, Kavli Institute of Nanoscience, Delf University of Technology, 2600 GA Delf, Netherlands.
(3) Institute of Applied Physics, Abbe Center of Photonics, Friedrich Schiller University Jena, Albert-Einstein-Str. 15, 07745 Jena, Germany.

evdiaes@doctor.upv.es

Interference between different radiative modes supported by high-index dielectric particles can eventually lead to scattering cancellation in the far-field, resulting in anapole resonances [1]. Such non-radiative resonance is accompanied by a strong field concentration inside the nanoparticle, which has been used to boost light-matter interaction and to enhance nonlinear effects such as harmonic generation or Raman scattering [2]. So far, all experiments showing anapole resonances, in silicon nanodisks, have been achieved by external normal illumination. In this work, we report on the reduction of scattering produced by silicon nanodisks resulting from anapole resonances when excited on-chip using silicon waveguides at telecom wavelengths fo use in photonic integrates circuits. We observe a strong reduction of the top out-of-chip scattering from the silicon disks when the conditions for appearance of the anapole resonance are met. To get further insight into the disk behavior, we performed phase- and polarization-resolved SNOM measurements [3] on the waveguide-disk system at different wavelengths. At wavelength around the expected anapole resonance, we observed the formation of three lobes in the transversal electric field component, a feature not observed at larger wavelengths, and a clear fingerprint of the anapole condition. Our work can pave the way towards integration of silicon disks in complex photonic integrated circuitry for applications such as sensing or nonlinear photonics.

REFERENCES

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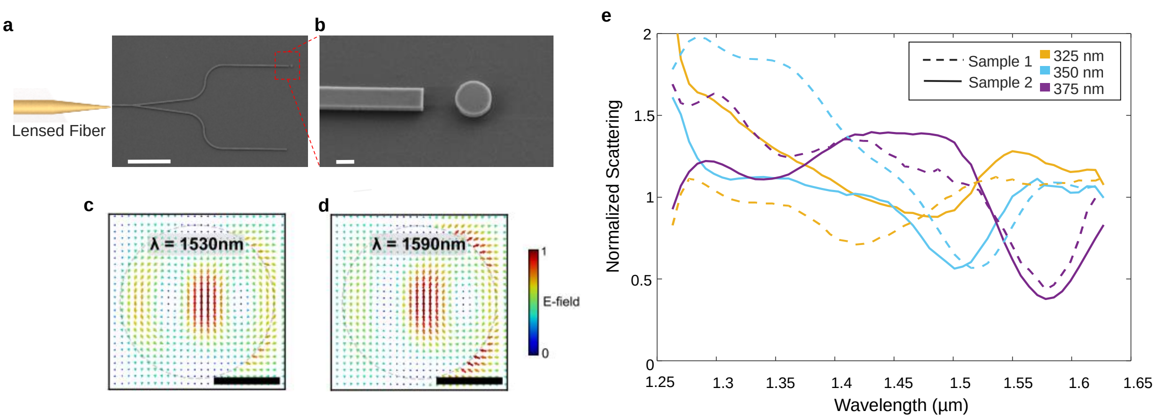

Figure 1: Far-field top-scattering measurements. **a**, SEM picture of one of the fabricated circuits. Scale bar: 10 mm. **b**, SEM image showing in detail the disk and the waveguide termination. Scale bar: 400 nm. **c**, Electric field lines at the anapole and **d** maximum energy wavelengths under waveguide illumination for a r=350nm disk. **e**, Experimental results of the normalized top-scattering recorded for disks with different radii (nominal values shown in the figure) in two different samples.