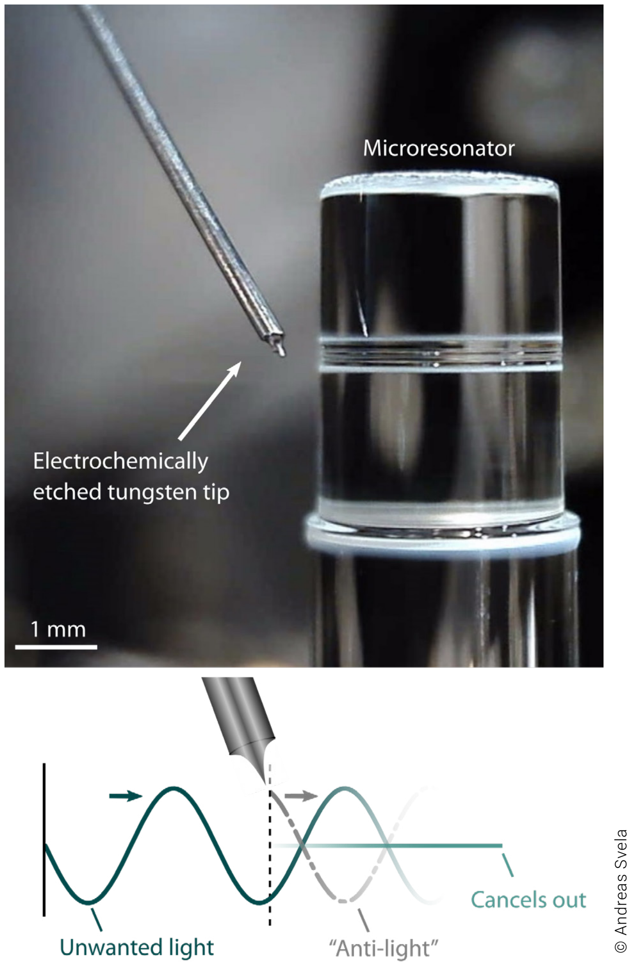

# Darkness from light

## ERLANGEN, 28 DECEMBER 2020

**Microresonators are small glass structures in which light can circulate and build up in intensity. Due to material imperfections, some amount of light is reflected backwards, which is disturbing their function. Researchers have now demonstrated a method for suppressing these unwanted back reflections. Their findings can help improve a multitude of microresonator-based applications from measurement technology such as sensors used for example in drones, to optical information processing in fibre networks and computers. The results of the team spanning the Max Planck Institute for the Science of Light (Germany), Imperial College London, and the National Physical Laboratory (UK) are published now in the *Nature*-family journal *Light: Science and Applications*.**




Top: An optical microresonator and a sharp tungsten tip. The tip's position can control the amount of back reflections in the microresonator. The authors show more than 30 dB suppression below the intrinsic backscattering.

Bottom: The unwanted (intrinsic backscattered) light to the left is cancelled out by the out-of-phase light ("anti-light" similar to "anti-noise" in noise cancelling headphones) introduced by the metal tip.

Researchers and engineers are discovering many uses and applications for optical microresonators, a type of device often referred to as a light trap. One limitation of these devices is that they have some amount of back reflection, or backscattering, of light due to material and surface imperfections. The back reflected light negatively impacts the usefulness of the tiny glass structures. To reduce the unwanted backscattering, the British and German scientists were inspired by noise cancelling headphones, but rather using optical than acoustic interference.

"In these headphones, out-of-phase sound is played to cancel out undesirable background noise," says lead author Andreas Svela from the Quantum Measurement Lab at Imperial College London. "In our case, we are introducing out-of-phase light to cancel out the back reflected light," Svela continues.



Max Planck Institute for the Science of Light    Staudtstraße 2    91058 Erlangen    Germany
Contact: Lothar Kuhn    E-Mail: MPLpresse@mpl.mpg.de    Phone: +49 9131 7133 825
mpl.mpg.de    /PhysikDesLichts    @MPI_Light    @physik_des_lichts

To generate the out-of-phase light, the researchers position a sharp metal tip close to the microresonator surface. Just like the intrinsic imperfections, the tip also causes light to scatter backwards, but there is an important difference: The phase of the reflected light can be chosen by controlling the position of the tip. With this control, the added backscattered light's phase can be set so it annihilates the intrinsic back reflected light – the researchers produce darkness from light.

"It is an unintuitive result, by introducing an additional scatterer, we can reduce the total backscattering," says co-author and principal investigator Pascal Del'Haye at the Max Planck Institute for the Science of Light. The published paper shows a record suppression of more than 30 decibels compared to the intrinsic back reflections. In other words, the unwanted light is less than a thousandth of what it was prior to applying the method.

"These findings are exciting as the technique can be applied to a wide range of existing and future microresonator technologies," comments principal investigator Michael Vanner from the Quantum Measurement Lab at Imperial College London. For example, the method can be used to improve gyroscopes, sensors that for instance help drones navigate; or to improve portable optical spectroscopy systems, opening for scenarios like built-in sensors in smartphones for detection of dangerous gasses or helping check the quality of groceries. Furthermore, optical components and networks with better signal quality allow to transport more information even faster.

**Original publication:**
A. Ø. Svela, J. M. Silver, L. Del Bino, S. Zhang, M. T. M. Woodley, M. R. Vanner, and P. Del'Haye: Coherent suppression of backscattering in optical microresonators, Light: Science and Applications (2020), https://doi.org/10.1038/s41377-020-00440-2

**Contact:**
Dr Pascal Del'Haye, pascal.delhaye@mpl.mpg.de

*Research at the Max Planck Institute for the Science of Light (MPL) covers a wide range of topics, including nonlinear optics, quantum optics, nanophotonics, photonic crystal fibres, optomechanics, quantum technologies, biophysics, and – in collaboration with the Max-Planck-Zentrum für Physik und Medizin – links between physics and medicine. MPL was founded in 2009 and is one of the over 80 institutes that make up the Max Planck Society, whose mission is to conduct basic research in the service of the general public in the natural sciences, life sciences, social sciences and the humanities.*



Max Planck Institute for the Science of Light Staudtstraße 2 91058 Erlangen Germany
Contact: Lothar Kuhn E-Mail: MPLpresse@mpl.mpg.de Phone: +49 9131 7133 825
mpl.mpg.de /PhysikDesLichts @MPI_Light @physik_des_lichts