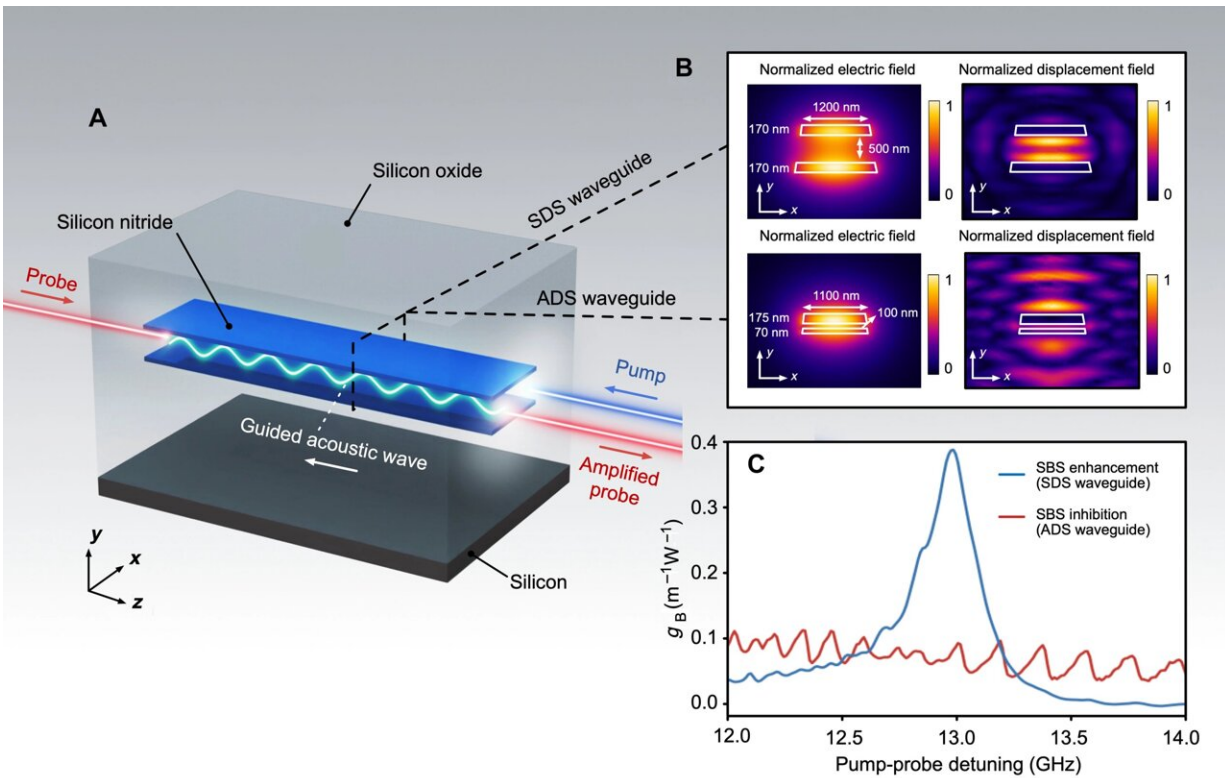


New technique to trap soundwaves and light on a chip in large-scale circuits

October 10 2022



Guided-acoustic Brillouin scattering in multilayer silicon nitride waveguides. (A) Artistic representation of the multilayer silicon nitride waveguide, showing the enhanced backward SBS process with the acoustic wave guided between the silicon nitride layers. (B) Simulated optical modes and acoustic responses of the SDS and ADS waveguides, respectively. SDS and ADS are two variances of the multilayer silicon nitride waveguides. (C) The calculated Brillouin gain coefficients of the standard SDS and ADS waveguides. The SDS waveguide shows enhanced SBS with a gain coefficient three to five times larger than previously demonstrated in silicon nitride, while the ADS waveguide shows

inhibited SBS, with a Brillouin gain coefficient below $0.1 \text{ m}^{-1} \text{ W}^{-1}$. Credit: *Science Advances* (2022). DOI: 10.1126/sciadv.abq2196

In recent decades, chips and electronic devices have become exponentially smaller and faster. Engineers have nearly reached the limits of traditional electronics and are now in the process of transitioning from electronics to photonics, using light instead of electrons. At this scale, all kinds of new challenges arise. For example, the smallest interferences or quantum effects can distort signals and render them unusable. Now, a research team from the University of Twente have added a new solution to the photonic toolbox.

The filtering, amplifying and processing of optical signals is essential in the development of new telecommunication techniques, quantum optics and sensors. One pathway to do this effectively is by using a coherent optomechanical interaction technique called stimulated Brillouin scattering. In this technique, two finely tuned lasers generate a soundwave with frequencies 1 million times higher than the human hearing threshold and trap it in a waveguide. Light sent through the waveguide interacts with the soundwave, which will reflect a very small and specific part of the light spectrum; effectively filtering the signal.

"Even though Brillouin scattering has been studied extensively in the last few years, it could never be implemented reliably on a chip suitable for use in our daily lives," tells Prof David Marpaung, professor leading the Nonlinear Nanophotonics research group. "Trapping the soundwave in a waveguide long enough to be effective, has proven to be very difficult. 'Acoustic leakage' is a big problem in traditional [silicon](#)-based platforms preventing strong Brillouin interactions. And alternative materials are often unstable, fragile, or even toxic."

Breakthrough with multilayer silicon nitride waveguide

The research team at the University of Twente has used low-loss multilayer silicon [nitride](#) (Si_3N_4) nanophotonic circuits to confine both the optical and the acoustic waves. These circuits consist of 50 cm-long spiral waveguides. This setup traps the soundwave and prevents the acoustic leakage that occurs when using a single silicon nitride core. Besides promising results in their experimental setup, the researchers produced a working proof of concept and other practical implementations. Roel Botter, first author of the paper, says, "We demonstrated an RF cancelation notch filter, and the results show great potential for future stimulated Brillouin scattering on a silicon nitride chip."

Marpaung adds, "Our research makes integration of stimulated Brillouin scattering in large circuits possible. These new chips can be integrated with other emerging technologies such as tunable lasers, frequency combs, and programmable photonic circuits, potentially giving them a part in the future development of fields ranging from telecommunications to quantum computing."

The research paper, published on Oct. 7 in *Science Advances*, is the result of a 4-year study on the feasibility of stimulated Brillouin scattering in silicon nitride photonic circuits. The research took place at the MESA+ institute at the University of Twente, in collaboration with Dr. Yang Liu, scientist at the Laboratory of Photonics and Quantum Measurements at EPFL in Switzerland. The silicon nitride chips are produced by LioniX International, a spin-off of the University of Twente, and an indispensable partner in the [research process](#).

More information: Roel Botter et al, Guided-acoustic stimulated

Brillouin scattering in silicon nitride photonic circuits, *Science Advances* (2022). [DOI: 10.1126/sciadv.abq2196](https://doi.org/10.1126/sciadv.abq2196)

Provided by University of Twente

Citation: New technique to trap soundwaves and light on a chip in large-scale circuits (2022, October 10) retrieved 26 June 2024 from <https://phys.org/news/2022-10-technique-soundwaves-chip-large-scale-circuits.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.