# Enhanced sensitivity of silicon-photonics-based ultrasound detection via BCB coating

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## Background, Motivation and Objective

*In biomedical applications, ultrasound detection is conventionally performed with piezoelectric transducers. Due to the opacity of piezoelectric transducers and their reduced sensitivity upon miniaturization, there is a need for the development of new detection methodology. Recently, ultrasound detection has been demonstrated with waveguides fabricated in silicon-on-insulator (SOI) substrates. Ultrasound detection via silicon (Si) waveguides relies on the ability of acoustic waves to modulate the effective refractive index of the guided modes. However, the low photo-elastic response of Si and $SiO_2$ has limited the sensitivity of conventional SOI sensors. In this study, we demonstrate that the sensitivity of Si waveguides to ultrasound may be significantly enhanced by replacing the $SiO_2$ over-cladding with bisbenzocyclobutene (BCB) – a transparent polymer with a high photo-elastic coefficient.*

## Methods

*We experimentally characterized the response of the Si waveguides shown in Figs. 1a and 1b to ultrasound for longitudinal acoustic waves. The acoustic waves were ultrasound bursts generated by a cylindrically focused ultrasound transducer with a central frequency of 15 MHz. The resulting phase variations in the waveguide at $\lambda$ =1540 nm was monitored using interferometric setup described in Fig. 1c.*

## Results/Discussion

*We have experimentally demonstrated that the BCB over-cladding enhanced the signal by a factor of 4.98 (Fig. 1d). Using our theoretical model and accounting for a 10 nm fabrication error in each of the dimensions of the waveguide, the enhancement in sensitivity were 3.9±2.3 for the TM mode, in good agreement with the experimental value. The enhancement in sensitivity may be solely attributed to the high photo-elastic coefficients of BCB. The use of Si waveguide with a polymer over-cladding may be regarded as a hybrid approach that exploits the advantages of both materials, combining the miniaturization level offered by Si photonics with the high photo-elastic response of BCB, leading to the sensors with sensitivity values comparable to those achieved with polymer waveguides.*

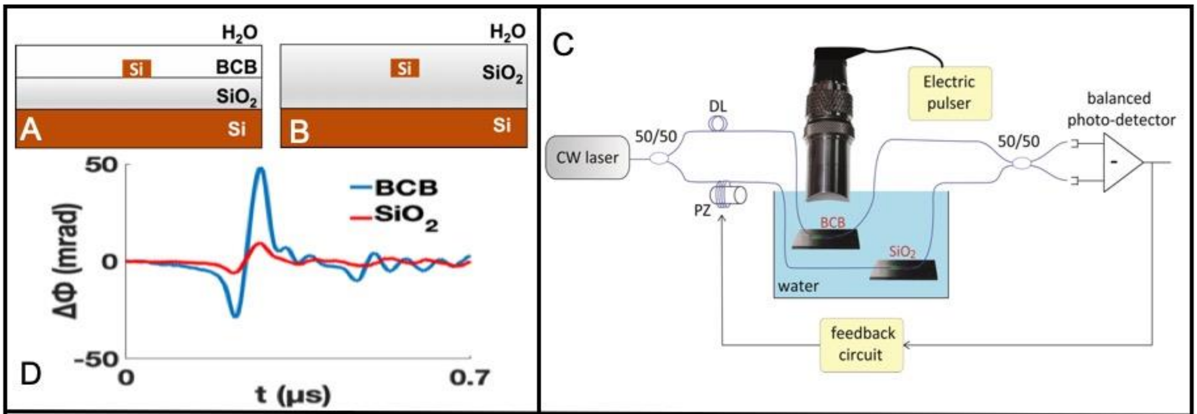


Fig. 1. A, B Chip cross section: BCB over-cladding, Silica over-cladding, C. Measurement setup: a Mach-Zehnder interferometer was constructed, where in each of the interferometer arms a chip with a different over-cladding material (BCB or silica) was connected, D. Acoustic signal comparison