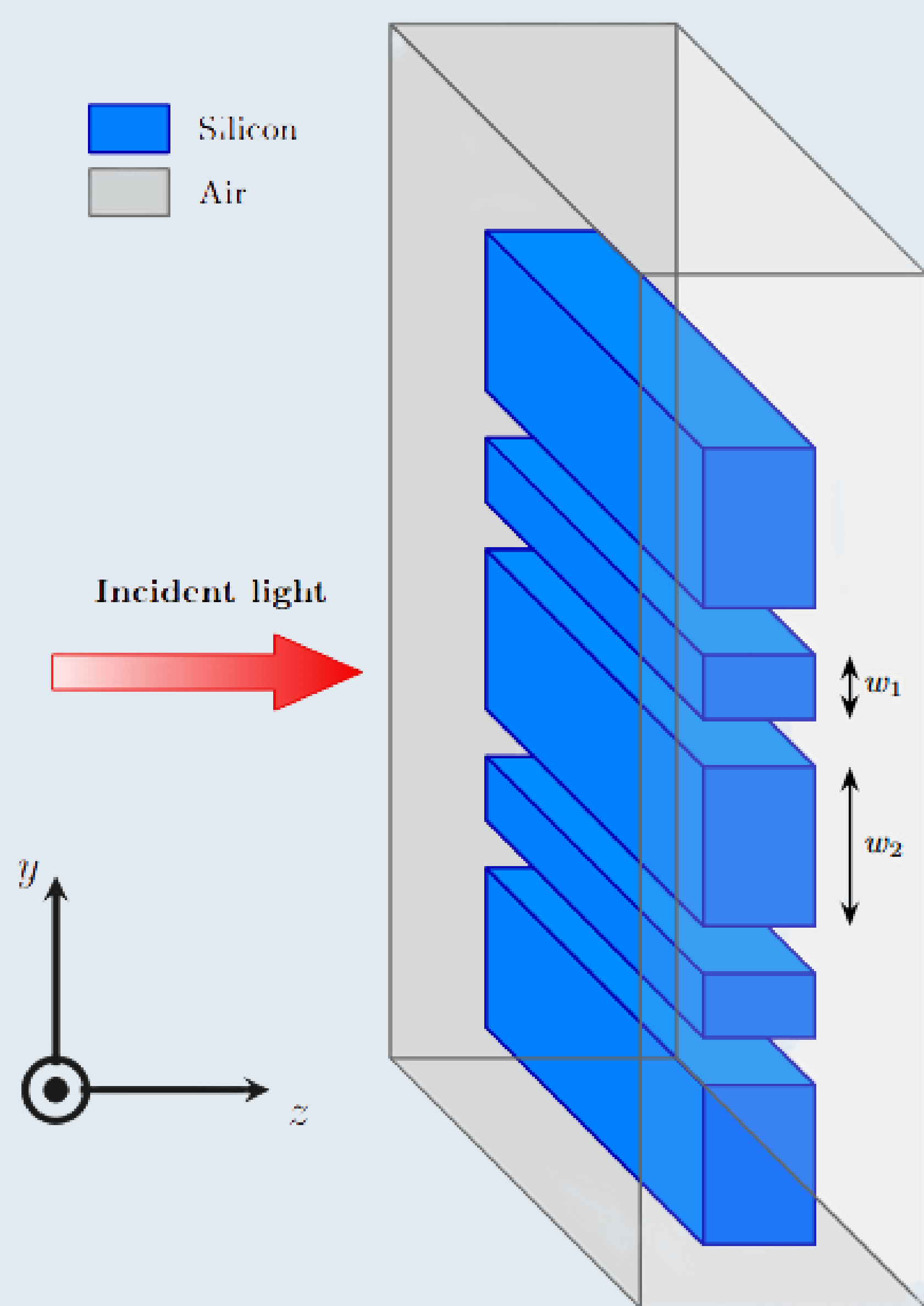




# Investigation of Resonances in Silicon Nanobar Arrays via Geometric Asymmetry

Optimize 1D silicon nanobar arrays for operation near the 1550 nm telecom wavelength by tailoring structural asymmetry and resonant behavior.

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## Introduction

Silicon-based integrated photonics offers a versatile platform for next-generation technologies [1]. Combined with advanced beam-shaping methods, nanosecond laser writing enables the fabrication of nanoline arrays [2], providing a scalable and maskless route for engineering complex photonic architectures.

Furthermore, selective wet etching of the laser-modified regions transforms the patterns into silicon–air

nanostructures. The resulting high-index-contrast architectures enable stronger optical confinement and enhanced light–matter interactions, making them attractive for metasurfaces, diffractive optics, and other nanophotonic devices.

The excitation and tuning of high-Q resonances in silicon nanobar arrays are investigated through intentional geometric symmetry breaking.

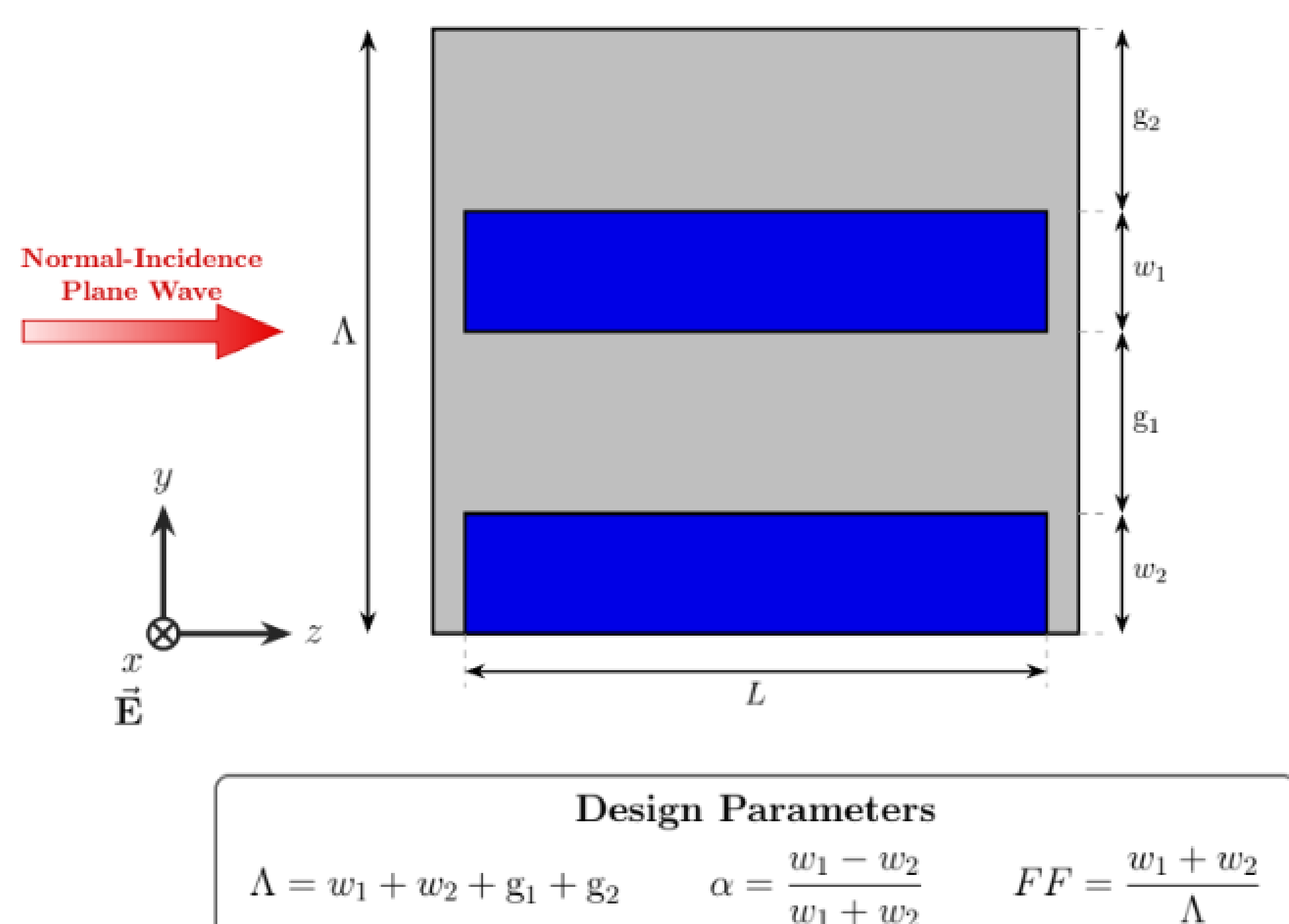


FIGURE 1. Schematic of the unit cell and design parameters.

## Methodology

Full-wave simulations were performed using the COMSOL Multiphysics® Wave Optics Module with Floquet periodic boundary conditions.

Frequency-domain and eigenfrequency analyses were used to evaluate the transmittance spectra, resonant eigenmodes, field distributions, and quality ( $Q$ ) factors.

The period ( $\Lambda$ ), fill factor ( $FF$ ), and geometric asymmetry parameter ( $\alpha$ ) were systematically optimized to tailor the resonant response near the 1550 nm telecom wavelength.

## Results

The resulting transmittance spectra are shown in Fig. 2 for the optimized design with a fixed period of  $\Lambda = 2240\text{nm}$  and fill factor  $FF = 0.4$ , at different values of the asymmetry parameter  $\alpha$ . Increasing  $\alpha$  progressively shifts the main resonance toward longer wavelengths and modifies its linewidth and coupling strength.

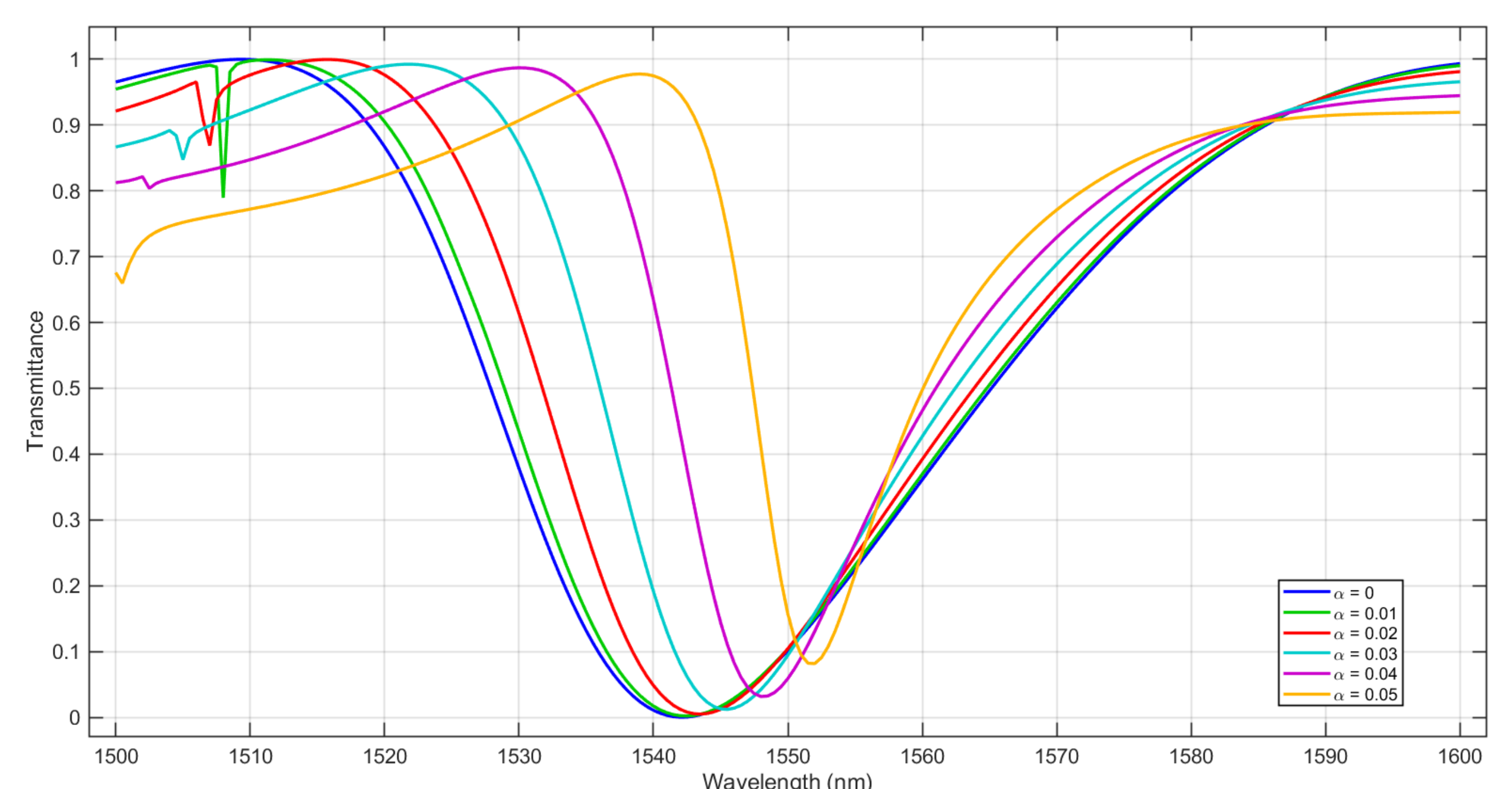


FIGURE 2. Transmittance spectra of the optimized 1D silicon nanobars.

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**Acknowledgement:** The authors acknowledge support from TÜBİTAK grant no: 223M151.

ÖZYEĞİN  
ÜNİVERSİTESİ

