Surface lattice and silver coating assisted mid-infrared reflection reduction of micropore arrays etched in silicon wafers

Quang Minh Ngo,

Xuan Bach Nguyen,

Thanh Son Pham,

Anh Tu Tran,

Alexander Dolbik[1],

Taisa Orehovskaya[1],

Serguei Lazarouk[1]

2025

[1]Belarusian State University of Informatics and Radioelectronics, 6 P. Brovki Street, Minsk, 220013, Belarus.

Keywords: Mid-infrared devices, Metasurfaces, Optical resonators, Subwavelength structures, Optical design and fabrication.

Abstract: In this work, we report the design, numerical simulation, and fabrication of mid-infrared metasurfaces consisting of two-dimensional periodic arrays of silver coated-micropores patterned on silicon wafer. The structures with regular arrangements of square and triangular lattices, lattice constants, pore diameters, and silver coated micropore thicknesses were designed, and their optical characteristics were analyzed using the finite-difference time-domain method. The designed reflectors work in the mid-infrared range of 7–24 μm and strongly depend on the surface lattice, silver film, and fill-factor of the silver taken place in the silicon wafer. By introducing and applying the electrochemical fabrication processes for silicon wafers, the diameters of ~ 4–15 μm and depth of ~ 30–50 μm of the micropores in silicon wafer

depending on the anodic current density of ~ 4–10 mA/cm2 at given anodization time of ~ 5–30 min, and then the silver films of ~ 0.2–1.5 μm formed into micropores have been shown. The fabricated samples were characterized using Fourier transform infrared reflection measurements, which showed good agreement with the simulations. We have demonstrated an alternative implementation of the reflectance metasurfaces working in the mid-infrared region without using the precise fabrication techniques. This work provides general guidelines and useful approaches for designing mid-infrared metasurface devices.

Publication source: Surface lattice and silver coating assisted mid-infrared reflection reduction of micropore arrays etched in silicon wafers / Quang Minh Ngo, Xuan Bach Nguyen, Thanh Son Pham [et al.] // Infrared Physics and Technology. – 2025. – Volume 147. – P. 105817. – DOI: https://doi.org/10.1016/j.infrared.2025.105817.