Design and theoretical evaluation of (BTO/Y2O3)N/YBCO/(BTO/Y2O3)N tunable photonic filters with visible-NIR optical response

L. M. Segura-Gutierrez[1], Luz E. González[2,3], J. E. Ordoñez[1], G. Zambrano[1], W. Loperal & John H. Reina[3,4]

[1]Thin Films Group, Departamento de Física, Universidad del Valle, 760032 Cali, Colombia. [2]Facultad de Ciencias Naturales y Matemáticas, Universidad de Ibagué, 730001 Ibagué, Colombia. [3]Centre for Bioinformatics and Photonics (CIBioFi), Universidad del Valle, Edificio E20 No. 1069, 760032 Cali, Colombia. [4]Quantum Technologies, Information and Complexity Group, Departamento de Física, Universidad del Valle, 760032 Cali, Colombia. .

We design and evaluate optical filters that are built from one-dimensional photonic crystals (1D PCs) for integration into optical networks based on wavelength division multiplexing (WDM). These filters route and switch optical signals at certain wavelengths in the visible or near-infrared spectral regions, following the optical telecommunication channels currently available. The proposed photonic heterostructures comprise the integration of ferroelectric (BaTiO3), dielectric (Y2O3), and superconducting materials (YBa2Cu3O7). We theoretically validate our findings above and below critical superconductor temperature, thus providing an implementation of optical filters based on photonic crystals that can be integrated into either photonic and optoelectronic circuits or in devices for the transmission of information in the visible and near-infrared range at very low- temperature environments (e.g., outer space).

In a previous work [1], we have succeeded at experimentally realizing ferroelectric/superconductor 1D photonic crystals as suitable engineered nanosystems for tuning and controlling electromagnetic wave propagation in a wide region of the visible spectrum. Here, we present a novel (BTO/Y2O3)N/YBCO/(BTO/Y2O3)N photonic heterostructure composed of N alternating layers of dielectric/ferroelectric materials and a superconductor defect layer in between. Our work covers a wide range of attainable fabrication parameters for tuning the optical response of single-channel photonic filters such as thickness, temperature, number of periods N, and direction of incident radiation.

[1] González, L. E., Ordoñez, J. E., Melo-Luna, C. A., Reyes, D., Zambrano, G., Porras- Montenegro, N., Granada, J. C., Gómez, M. E., Reina, J. H. "Experimental realisation of tunable ferroelectric/superconductor (BTO/YBCO) N/STO 1D photonic crystals in the whole visible spectrum", Sci. Rep. 10, 13083 (2020). https://doi.org/10.1038/s41598-020-69811-4.

Biography

Lina Marcela Segura Gutiérrez was born in Cali, Colombia, in 1995. She is currently a Materials Engineering student at the Universidad del Valle, Cali - Colombia. She is involved in the study of 1D photonic crystals based on ferroelectric/superconductor materials and in the fabrication and structural characterization of photonic heterostructures.

lina.segura@correounivalle.edu.co