Tunable Tamm Plasmon Resonance based on Nanoporous Anodic Alumina Photonic Crystals

Lluís F. Marsal
Alejandro Rojas Gómez, Laura K. Acosta, Josep Ferré-Borrull
Departament d'Enginyeria Electrònica, Elèctrica i Automàtica, Universitat Rovira i Virgili, Avinguda Països Catalans 26, 43007 Tarragona, Spain
lluis.marsal@urv.cat

Abstract

Hybrid materials were designed by gold coating on porous nanostructures to create a metal/dielectric interface at which surface modes of electromagnetic field propagation can be generated [1]. The creation of resonance Tamm optical states in gradient index filters based on nanoporous anodic alumina (NAA-GIFs) was investigated. The NAA-GIFs were fabricated using a sinusoidal pulse-like anodization technique [2-4] that produces slight periodic modulations of the nanopores in the one-dimensional photonic alumina crystals (1D-PCs) obtained. The influence of the structural properties of 1D-PCs [5] and the thickness of the gold layers coated by sputtering on reflectance spectra were analyzed. The main photonic features of the fabricated samples were presented and discussed. The controlled nanofabrication of these novel structures allows obtaining better quality factors than in similar photonic nanostructures and the Tamm resonance spectra are narrower than the photonic bands themselves (**figure 1**). This gold-NAA photonic crystal structures open new opportunities for use as bio-sensors and optoelectronics devices.

Acknowledgments

This work was supported by the Spanish Ministerio de Ciencia e Innovación (MICINN/FEDER) PDI2021-128342OB-I00, by the Agency for Management of University and Research Grants (AGAUR) ref. 2017-SGR-1527, COST Action 20126 - NETPORE and by the Catalan Institution for Research and Advanced Studies (ICREA) under the ICREA Academia Award.

References

[1] M. Kaliteesvski, I. Iorsch, S. Brand, R. A. Abram, J. M. Chamberlain, A. V. Kavokin, and I. A. Shelykh, Physical Review B, 76 (2007) 165415.
[2] G. Macias, J. Ferré-Borrull, J. Pallarès, and L. F. Marsal, Nanoscale Research Letters, 9 (2014) 315.
[3] L. K. Acosta, F. Bertó-Roselló, E. Xifre-Perez, A. Santos, J. Ferré-Borrull, L. F. Marsal, ACS Applied Materials and Interfaces, 3 (2019) 2561-3628.
[4] L. K. Acosta, F. Bertó-Roselló, E. Xifre-Perez, C. Suwen Law, A. Santos, J. Ferré-Borrull, L. F. Marsal, ACS Applied Materials and Interfaces, 17 (2020) 19245-20146.
[5] J. Ferré-Borrull, J. Pallarès, G. Macías and L. F. Marsal, Materials, 7 (2014), 5525-5253.

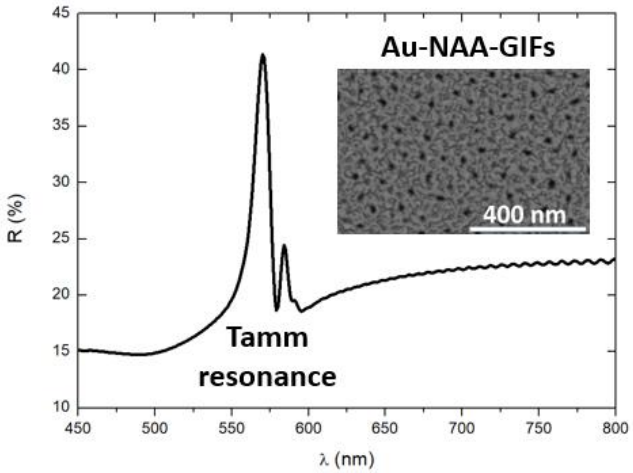

Figure 1: Reflectance spectrum of NAA-GIF coated with gold (Au-NAA-GIF) showing the characteristic dip corresponding to a Tamm resonance signal. Top view of Au-NAA-GIF (inset).