Three-dimensional interconnected anodized aluminum oxide (3D-AAO) metamaterials using different waveforms and metal layers for RGB display technology applications

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Research into the artificial reproduction of vibrant colours in natural creatures and the reproduction of their structural colours has generated considerable interest. One inorganic material that has been studied for the generation of these artificial colours is anodic aluminium oxide (AAO)[1-2]. For example, 3D anodic aluminium oxide (3D-AAO)[3-4] metamaterials act as distributed Bragg reflectors. This study examines the effect of the application of various waves (square, sinusoidal, and sawtooth) during the generation of 3D-AAO on the optical and morphological properties of these 3D metamaterials. The effect of the waveform in the colours and hues have been explained by a theoretical model. Furthermore, the work analyses how colour can be improved by depositing a thin metal layer on top, obtaining, from a simplistic point of view, a combination of two effects: A Bragg reflector (3D-AAO) and an optical reflector (metal mirror). For that, different metals like Au, Pt, and Cr have been studied. The thickness of the metal layer has been theoretically modelled[5]. This study paves the way for a new approach to developing structural colours for their use in for example RGB display technologies.

References

[1] Manzano, C. V.; Ramos, D.; Pethö, L.; Bürki, G.; Michler, J.; Philippe, L. Journal of Physical Chemistry C, 122, 1 (2018) 957-963.

[2] Manzano, C. V.; Best, J. P.; Schwiedrzik, J. J.; Cantarero, A.; Michler, J.; Philippe, L. Journal of Materials Chemistry C 4, 32 (2016) 7658-7666.

[3] Ruiz-Clavijo, A.; Tsurimaki, Y.; Caballero-Calero, O.; Ni, G.; Chen, G.; Boriskina, S. V.; Martín-González, M. ACS Photonics 5, 6 (2018) 2120-2128.

[4] Martín, J.; Martín-González, M.; Francisco Fernández, J.; Caballero-Calero, O. Nature Communications 5, (2014) 5130.

[5] Manzano, C. V.; Rodríguez-Acevedo, J.; Caballero-Calero, O.; Martín-González, M. Journal of Materials Chemistry C 10, 5 (2022) 1787-1797.

Figures

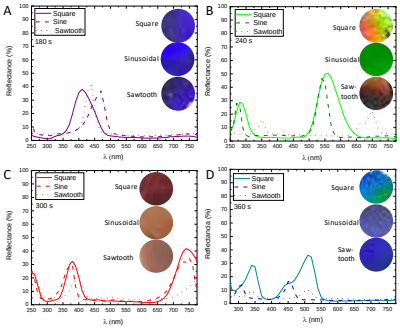

Figure 1: UV-Vis reflectance spectra as a function of the wavelength of 3D-AAO nanostructures or different waves and rest times. (a) 180 s, (b) 240 s, (c) 300 s, and (d) 360 s. In the inset, optical images of 3D-AAO colour for different waves and resting times were studied.