Metamaterials based on nanoporous anodic aluminium oxide for passive radiative cooling applications

Alba Díaz-Lobo, Ángel Morales-Sabio, Marisol Martin-González, Cristina V. Manzano

Instituto de Micro y Nanotecnología (IMN-CNM), CSIC (CEI UAM+CSIC), Isaac Newton, 8, E-28760, Tres Cantos, Madrid, Spain
alba.diaz@csic.es

The development of metamaterials with tunable photonic properties is followed by interesting possibilities for energy saving and harvesting, among others. A significant reduction in energy demand will be achieved when passive radiative cooler technology meets low-cost, easy-scalable to industry metamaterials. The crucial optical requirements are both high reflectance of the solar radiation and a strong thermal radiation. Since cooling was demonstrated using nanoporous anodic aluminium oxide (AAO) membranes[1], these nanostructures have been involved as the principal material as well as useful templates for achieving passive radiative cooling. A detailed analysis about AAO-Al films, including: fabrication by two-step anodization process in different electrolytes (phosphoric acid, oxalic acid, sulphuric acid and ethylene glycol containing sulphuric acid); morphological characterisation (SEM and AFM) of pore diameter, interepore distance, pore's arrangement order grade, porosity, and different alumina thickness; and the impact of these parametes in the optical response from UV-Vis to mid-IR. The solar reflectance and the thermal emission have been characterised, achiving UV-Vis to near-IR reflectivity above 80%[2], and an IR emissivity around 90% up to 8 µm. Aditionally, AAO-Al films' cooling performance have been experimentally studied during several day-night cycles.

References

[1] Fu, Y., et al., Solar Energy Materials and Solar Cells, 2019. 191: p. 50-54.
[2] Manzano, C., et al., Journal of Materials Chemistry C, 2016. 4(32): p. 7658-7666.

Figures

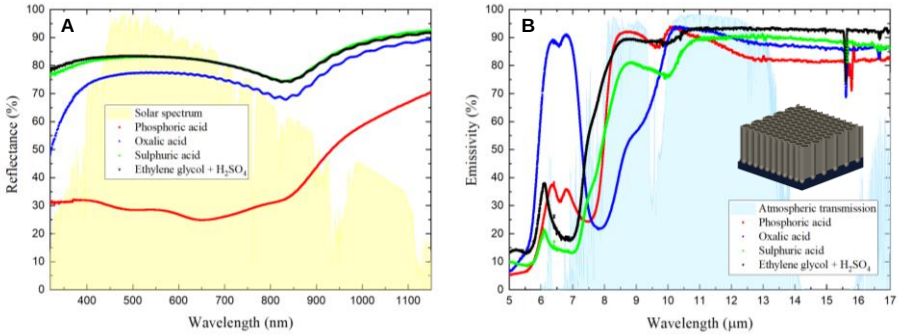

Figure 1: (A) AAO-Al films' reflectance from UV-Vis to near IR, over the solar irradiance spectrum. (B) AAO-Al films' IR emissivity above the atmospheric transmission spectrum. Nanostructure scheme is shown in the inset.