Tunable Multispectral Photonic Stopbands Based on Structurally Engineered Nanoporous Anodic Alumina

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The control of light–matter interactions at the nanoscale with precision is of fundamental importance for the development of advanced photonic devices and new photonic applications. Nanoporous anodic alumina (NAA) is an interesting base material for the fabrication of photonic structures. NAA is obtained by the electrochemical oxidation of aluminum that under specific conditions presents a self-ordered hexagonal pore distribution of parallel cylindrical nanopores [1-2]. The fabrication is cost-effective and fully scalable process compatible with conventional micro- and nanofabrication approaches.

NAA has been used to fabricate photonic crystals with the aim to control the properties of light when the electromagnetic waves travel across the matter. The photonic crystals are periodic structures with a periodic variation of the refractive index. The periodicity of these structures defines regions of the spectrum where the propagation of light is forbidden (photonic stopbands).

The fabrication of photonic structures (PSs) with multiple narrow photonic stopbands at different spectral positions (UV-Vis-NIR) remains a challenge These PSs can be obtained by averaging the sum of multiple sinusoidal waves into a single complex waveform, which is subsequently translated into anodization profiles to engineer the nanoporous structure of these PSs in depth. Each sinusoidal wave determines the spectral position and the reflectance amplitude of a forbidden photonic band or photonic stopband. Multiple-band NAA structures have interesting applications such as optical encoding tags [3], optical sensing [4], photonics [5] and photovoltaics. In this presentation, we present a comprehensive study of different photonic structures based on single and multiple periodic structures with sinusoidal profiles both in an overlapped and in a stacked configuration. We analyze different technological parameters and its effect on the structure and the stopbands. Finally, we will present some examples of sensing and optical encoding.

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