Light Emitting Aperiodic Photonic Structures
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The control of light-matter interactions in complex dielectrics without translational invariance offers the ultimate potential for the creation and manipulation of light states. Unlike periodically arranged dielectrics (photonic crystals), aperiodic dielectric arrays show unique light localization and transport properties related to the lack of translational symmetry, and an unprecedented degree of structural complexity. Aperiodic dielectrics can be deterministically generated following simple mathematical rules. They offer significant advantages over randomly generated non-periodic materials in terms of reproducibility, processing, and design. Recently [1,2] we fabricated the first light-emitting silicon-rich, SiNₓ/SiO₂ Thue-Morse (T-M) multilayer structures in order to investigate the generation and transmission of light in strongly aperiodic deterministic dielectrics. Photoluminescence and optical transmission data experimentally demonstrate the presence of emission-enhancement effects occurring at wavelengths corresponding to multiple T-M resonance light states. The unprecedented degree of structural flexibility of T-M systems can provide alternative routes towards the fabrication of optically active, multi-wavelength photonic devices.

Figure 1. (a) Experimental (solid line) and calculated (dotted line) transmission for the 32-layer T-M structure (TM32); (b) Experimental (solid line) and calculated (dotted line) transmission for the 64-layer T-M structure (TM64). For all the simulations we have considered n_A = 2.23 (SiNₓ), n_B = 1.45 (SiO₂). The thickness simulation parameters that yield the best fit with the experimental transmission data are d_A = 198.9 nm and d_B = 273 nm, which are approximately 6% thicker and 4% thinner than the targeted values defined by the Bragg condition at λ₀ = 1.65 mm.

Figure 2. (a) Experimental transmission for the 64-layer T-M structure; (b) Comparison of the room-temperature TM64 emission spectrum and the homogeneous SiNₓ-reference-sample emission spectrum. The pump power was 5mW.

REFERENCES: