Topology and Disorder in Amorphous Diamond and Gyroid-like Photonic Networks

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Abstract

I will present recent findings on high-index contrast dielectric networks, focusing on hyperuniform and local self-uniform architectures that sustain complete photonic bandgaps despite the absence of crystalline periodicity. Local self-uniform structures are the amorphous analog of a periodic gyroid structure with a threefold node topology, while hyperuniform and diamond networks exhibit a fourfold node topology. Our results are based on numerical simulations, experiments, and modeling. The discussion will highlight how local topology, structural statistics, and disorder influence the formation, position, and robustness of photonic bandgaps. By benchmarking these properties against crystalline analogs, we establish direct correspondences that help map the photonic phase space of amorphous networks. Beyond bandgap formation, these systems may also exhibit Anderson localization near the bandgap. Importantly, new structural design strategies for amorphous architectures enable controlled tuning of disorder, offering flexibility not easily achievable in crystalline systems, where defect engineering is conceptually and practically constrained.

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