Photonic band gaps in random networks with tunable disorder and topology

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Structural colour arises from visible light interference in the presence of photonic nanostructures in many animals and plants.[1] As the dielectric contrast increases, such structures can form complete photonic band gaps, where light cannot enter the structure from any angle.[2] This phenomenon is well established for periodic systems, so-called photonic crystals, and is associated with a vanishing photonic density of states (PDOS) with striking consequences.[3] Suppressed fluctuations at long length scales, also known as *hyperuniformity*, are a necessary ingredient to produce a vanishing PDOS in amorphous structures.[4] However, the influence of the type of disorder on different length scales on the PDOS is not well understood. Here, I aim to establish and explain correlations between the network statistics and the emergence of a band gap. We start from a supercell of periodic networks with varying coordination number [5], and control the type and amount of disorder by evolving the network using a Metropolis Monte Carlo algorithm with varying input parameters.[6, 7] The photonic states are calculated for the initial (crystallographically ordered) network and its disordered counterparts. All nets are characterised by a set of order metrics, including an isotropy index, the pore size distribution, and bond statistics.

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