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Three-Dimensional All-Dielectric Photonic Topological Insulator[1]

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The discovery of two-dimensional topological photonic systems has transformed our views on propagation and scattering of electromagnetic waves, and a quest for similar states in three dimensions has been put forward. Here we demonstrate that symmetry protected three-dimensional topological states can be engineered in an all-dielectric platform with the electromagnetic duality between electric and magnetic fields ensured by the structure design. Magneto-electric coupling playing the role of a synthetic gauge field leads to a topological transition to an "insulating" regime with a complete three-dimensional photonic bandgap. An emergence of surface states with conical Dirac dispersion and spin-locking is unimpeded. Robust propagation of surface states along two-dimensional domain walls is confirmed numerically by first principle studies. The proposed system represents a table-top platform for emulating relativistic physics of massive Dirac fermions and the surface states can be interpreted as Jackiw-Rebbi states bound to the interface separating domains with opposite particle masses.

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