Evolution of Edge Modes in Photonic Topological Insulators

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Abstract

Photonic topological insulators (PTIs) have been extensively studied in recent years owing to their properties like unidirectional propagation of light which remain backscattering-free even in the presence of structural defects/disorders [1]. One way to achieve such a robust feature would consist of creating a topological mode localized in a Dirac gap at the interface between two topologically different valley photonic crystals (VPCs) [1, 2]. In this study, we numerically investigate the evolution of topological modes in different types of topological interfaces of PTIs. Here, the topological interfaces (i.e., zigzag-type interface and bridge-type interface [3]) are formed by merging two VPCs, wherein each VPC is formed by an array of air grooves patterned on silicon in a honeycomb lattice. The unit cell comprises two cylindrical air grooves of radii r_1 and r_2 (Fig. 1(a)) and the variable interface radius is denoted by r_i (Fig. 1(b)). By merely changing the value of r_i, the zigzag interface is gradually transformed into a bridge interface as shown in Fig. 1(b). As r_i varies, one of the edge modes of the zigzag interface is gradually pushed toward the bulk bands, ultimately resulting in a single edge mode for the bridge interface. Currently, we are also extending such investigation to phononic topological crystals consisting of patterned plates, based on the valley Hall effect. Such studies could be beneficial in designing different topological insulators for the realization of low loss integrated photonic/phononic components.

Acknowledgments

The authors acknowledge the support from the project LEIT funded by the European Research Council (ERC) under the European Union’s Horizon 2020 research and innovation programme (Grant Agreement No. 885689).

References

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Figures

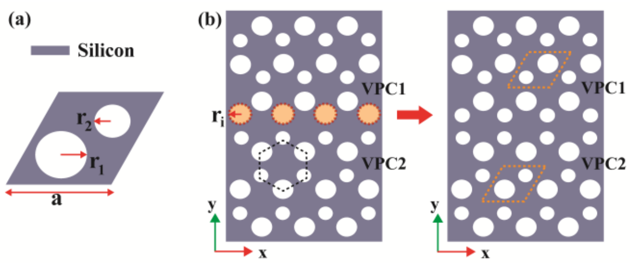

Figure 1: a) Unit cell of the VPC comprising two air grooves of radii r_1 and r_2, (b) Schematic illustration for the gradual evolution of the topological interface formed at the edge of VPC1 and VPC2. The variable interface radius is denoted by r_i.