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PHONONIC BAND-GAP MATERIALS DESIGN BY MEANS OF TOPOLOGY OPTIMIZATION

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Abstract. Phononic materials can exhibit phononic band gaps that prevent the propagation of elastic waves within certain frequency range, for this reason, they may be used to create frequency filters, as vibration or sound protection devices, as waveguides, or as beam splitters. In the present work, we show a topology optimization tool based on the topological derivative (J Sokolowski and A. Zochowski, SIAM J. Control Optim., 37(4):12511272 (1999)) and level-set concepts (S. Amstutz and H. Andra, J. of Computational Physics, 216(2):573-588 (2006)) for the design of biphasic periodic materials exhibiting phononic band gaps. We optimize two dimensional infinitely periodic materials by maximizing the relative width between two adjacent frequency bands making the range of prohibited frequencies wider. The finite element analysis is implemented using the Floquet-Bloch wave theory for solving the dynamic behavior of two-dimensional unit cells. Finally, we study the effect of imposing some predefined crystal symmetries on the band-gap width.