

1 **Supplementary Materials for “A Triply Periodic Minimal Surfaces-based**
2 **acoustic crystal with double-zero index”**

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18 **1. The parameter setting in TPMS Designer**

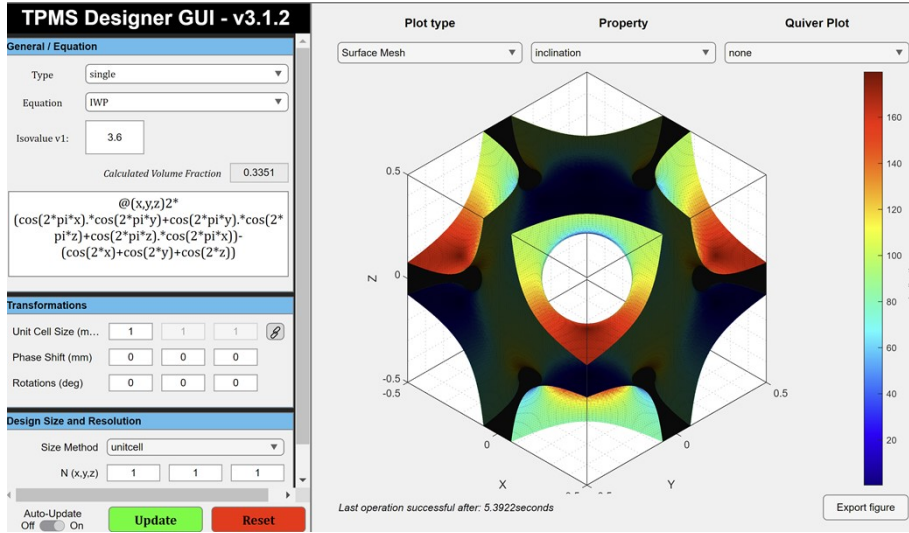
19 Figure S1 shows the parameter setting in TPMS Designer for generating the unit cell in the
20 main text.

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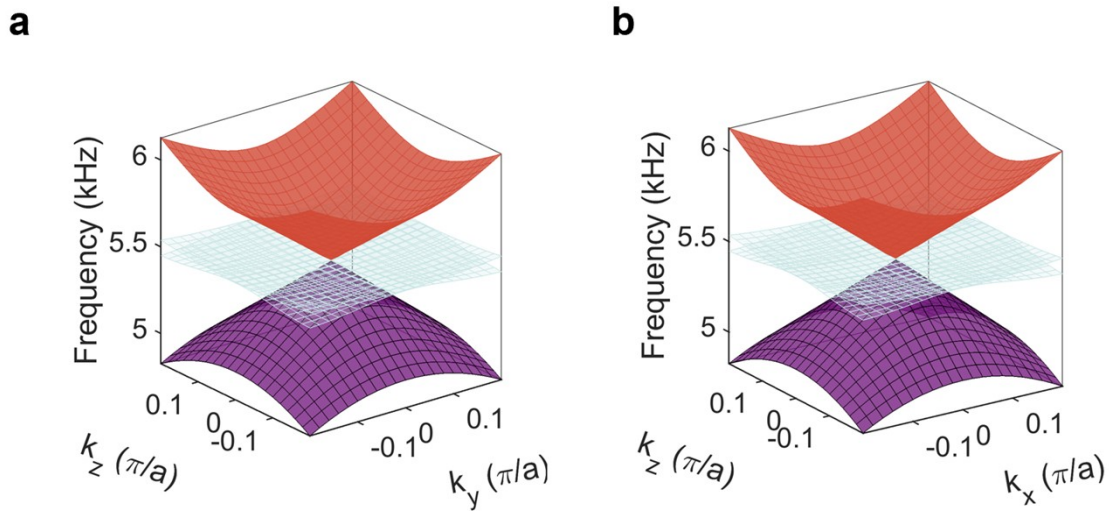
Fig. S1. The parameter setting in TPMS Designer.

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24 **2. The conical dispersions in the k_x-k_z and k_y-k_z planes near the Dirac-like cone**

25 The conical dispersions in the k_y-k_z and k_x-k_z planes near the Dirac-like cone are shown in **Fig.**

26 **S1**, showing a conical dispersion intersected by two flat bands.



27

28 **Fig. S2.** The conical dispersions in the k_x-k_z and k_y-k_z planes near the Dirac-like cone. **a**

29

In the k_x-k_z plane. **b** In the k_y-k_z plane.

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31 **3. The effect of thermoviscous boundary layer effects**

32 Without loss of generality, when the lattice constant is 50 mm, as adopted in this study, the

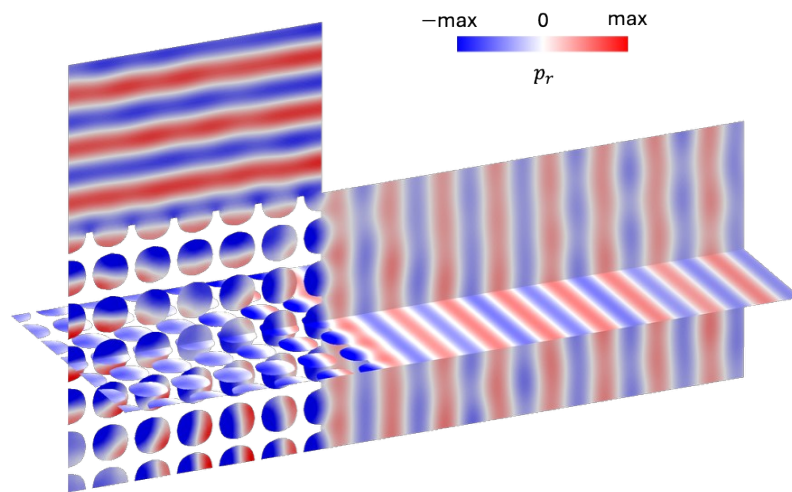
33 corresponding operating frequency is around 5500 Hz. According to acoustic theory, the
34 effective thermal-viscous boundary layer thickness is

$$35 \quad d_{vis} = 2.28 \sqrt{\frac{2\mu}{2\pi f \rho_0}},$$

36 where μ is the dynamic viscosity (1.81×10^{-5} Pa/s for air at 20 °C and 1atm), f is the operating
37 frequency, and $\rho_0 = 1.2$ kg/m³ is the air density under same condition. In this case, d_{vis} is
38 0.071 mm, which is much smaller than the characteristic dimension of the hollow regions.

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40 We further verified the wavefront modulation performance of the designed TPMS structure
41 under lossy conditions through numerical simulations. As shown in Fig. S3, the outgoing
42 wave exhibits high spatial uniformity and agrees well with its lossless counterpart (see the
43 Fig. 2a in main manuscript). Therefore, the effects of thermal and viscous losses are
44 negligible, as the unit cell dimensions are much larger than the thickness of the viscous
45 boundary layer at the frequencies considered.



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47 **Fig. S3.** The wavefront modulation simulation with the consideration of thermoviscous
48 boundary layer effects.

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50 **4. The numerical simulation of compression test**

51 We use the Solid Mechanics module in COMSOL Multiphysic to conduct the compression
52 simulation. In the simulation, the material's mechanical properties are the same as those of
53 the 3D-printed specimen in the compression experiment, where the Young's modulus is 61
54 MPa, the density is 1120 kg/m³, and the Poisson's ratio is 0.45. The simulated strain-stress
55 curve is shown in Fig. 4b in the main text, which agrees well with the experimental results.