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Electronic Supplementary Information

Two-dimensional natural hyperbolic materials: from polaritons modulation to applications

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Lonrentz model for calculating anisotropic permittivities of HMs

To describe the infrared permittivities of α-MoO_3 and α-V_2O_5 crystals in Fig. 3 in the main article, a three-parameter Lorentz oscillator model is used with

$$\varepsilon_{jj} = \varepsilon_{jj}^{\infty} \prod_{m}^{N} \frac{\left(\omega_{jm}^{LO}\right)^2 - \omega^2 - i\omega\Gamma_{jm}^{LO}}{\left(\omega_{jm}^{TO}\right)^2 - \omega^2 - i\omega\Gamma_{jm}^{TO}}, \quad j = x, y, z$$

where ε_{jj} denotes the principal components of the permittivity tensor, $\varepsilon_{jj}^{\infty}$ is the high-frequency dielectric constant. The parameters ω_{jm}^{LO} and ω_{jm}^{TO} represent the longitude and transverse optical phonon frequencies, respectively. The factor Γ_{jm} is the broadening factor of the Lorentzian lineshape. The superscripts *x*, *y*, and *z* indicate three principal axes of the crystal along the crystal directions [100], [001], and [010], respectively, and *m* is the mode index along three crystal directions. The detailed parameter values utilized in our calculation for α-MoO_3 and α-V_2O_5 are shown in Table S1.

Table S1 Parameter values used for calculating the anisotropic permittivities of α-MoO_3 and α-V_2O_5

HMs	Crystal directions	m	ω_{jm}^{LO} (cm^{-1})	ω_{jm}^{TO} (cm^{-1})	Γ_{jm}^{LO} (cm^{-1})	Γ_{jm}^{TO} (cm^{-1})	$\varepsilon_{jj}^{\infty}$
α-MoO_3	[100]	1	972	820	4.0	4.0	4.0
	[001]	1	851	545	4.0	4.0	5.2
	[010]	1	1004	958	2.0	2.0	2.4
α-V_2O_5	[100]	1	76.2	72.4	4.2	3.6	6.559
		2	265.5	261.0	8.0	13.0	
		3	390.5	303.0	12.2	15.0	
		4	586.0	411.0	30.0	5.0	
		5	959.0	767.5	50.0	30.0	
		6	982.0	980.5	15.0	10.0	
	[001]	1	490.0	473.0	15.0	18.0	6.142
		2	1038.0	975.5	2.5	2.5	
	[010]	1	225.0	212.0	7.5	10.5	3.899
		2	312.5	284.0	10.2	7.8	
		3	842.5	506.5	18.0	21.0	