Mechanical features of vdW crystals and nanomembranes

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Recent advances in synthesizing single-crystal van der Waals (vdW) materials and 2D layers have enabled large-area, high-quality samples, opening opportunities to explore diverse structural, electronic, magnetic, optical, magnetic, thermal, and vibrational properties. Yet, comparable control over elastic behavior remains limited, leaving a key question: can current experimental approaches reliably capture the mechanical properties of vdW systems, from bulk crystals to atomically thin layers?

Here we investigate anisotropic acoustic and elastic properties of vdW crystals using spontaneous Brillouin light scattering (BLS). This all-optical technique probes photon–phonon coupling via frequency shifts of light scattered by thermally excited hypersonic waves, directly linked to phonon velocities and elastic constants. We demonstrate BLS as a uniquely powerful, non-contact method for probing elastic anisotropy in fragile or ultra-thin vdW samples. Its applicability is validated for micrometer-scale crystals, with two complementary workflows introduced for transparent and opaque materials. Together with tailored analysis approaches, this establishes a versatile platform for extracting elastic, photoelastic, and dielectric tensors, bridging a longstanding experimental gap in the mechanical characterization of vdW materials.

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References

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