Imaging of Hyperbolic Plasmon-Phonon Polaritons in Twisted Double Bilayer Graphene

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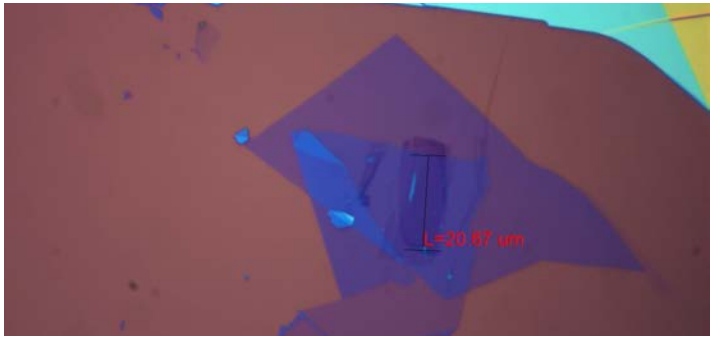
Two-dimensional (2D) materials are extremely thin (1000x thinner than human hair) materials whose optical and electronic properties change drastically compared to bulk material. 2D materials have many applications as semiconductors and superconductors, as well as in newer fields like quantum computing. By selective stacking and manipulation of lattice orientation angle, we can engineer materials with new and exotic properties. The layers in these materials are bonded with only van der Waals forces. Our device was made by stacking two layers of graphene between two layers of boron nitride. By exciting the material with a laser, the hyperbolic plasmon-phonon polaritons (HPPP)—a coupling of electron oscillations, crystal lattice oscillations, and photons—that result from this structure could be imaged using a scanning near-field microscope. HPPPs have potential applications in optoelectronic devices for focusing because of their ability to tune and confine electromagnetic energy at nano-scales.



Top: Video of polymer stamp picking up a flake of boron nitride (outlined in red)
Bottom: Two pieces of graphene sandwiched between boron nitride

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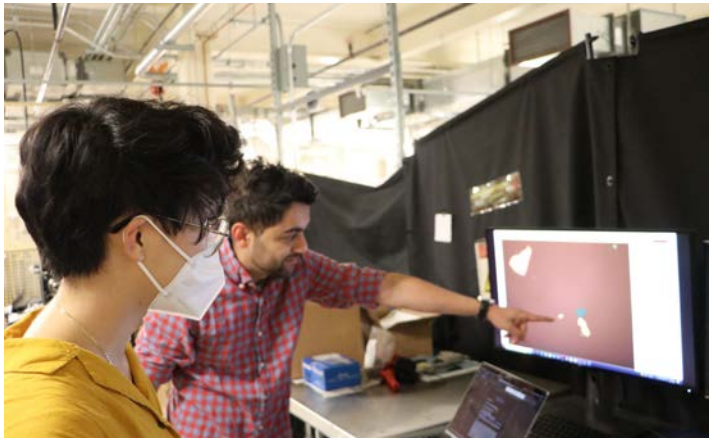
Anna Li is a rising senior at the University of California, Berkeley majoring in Materials Science and Engineering and minoring in Latin Language. She grew up loving chemistry, physics, and mineralogy. Through various science clubs in high school, found the field of materials science, which seemed like a perfect intersection of all her interests.

I have always been interested in research, and the Harvard REU has been an amazing experience. I got to work with the Center for Nanoscale Systems to make 2D materials and help test a new piece of equipment to help stack 2D materials. I learned how to use a lot of different types of machines and witnessed the amount of effort required to build and standardize new systems. I learned so much more in the limited time I spent at Harvard than I could have ever imagined, and my mentor was incredibly helpful and supportive. This has been a really unique opportunity, and I am excited to put these new skills to use as I continue to do research in the future!



Top: Anna, smiling for camera
Bottom: Anna with her mentor, Danial, looking at a flake of boron nitride