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RIKEN RAP

Ultrafast infrared nano-imaging of low-dimensional semiconductors

低次元半導体の超高速赤外ナノイメージング

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理研 和光キャンパス 研究交流棟 5F 会議室 W524-W525

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Low-dimensional materials such as transition metal dichalcogenide monolayers and carbon nanotubes (CNTs) exhibit strong quantum and dielectric confinement effects, producing tightly bound excitons that are highly sensitive to their surrounding environment. Understanding local variations in electron-hole dynamics is essential for engineering device performance. We employ ultrafast infrared scattering-type scanning near-field optical microscopy (ultrafast IR s-SNOM) to probe these dynamics with sub-picosecond temporal and ~100 nm spatial resolution. In CVD-grown WS_2, we observe slower carrier relaxation near edges, attributed to competing effects of sulfur vacancies and oxidation. In CNTs, we reveal heterogeneous exciton dynamics influenced by substrate strain and inter-tube interactions, including exciton transfer to metallic tubes. In addition, we demonstrate ultrafast optical control of hyperbolic phonon polaritons in hBN/WS_2 heterojunctions, visualizing transient modulation of polaritonic waves. Finally, we leverage ultrafast IR s-SNOM for tracking carrier transport in graphite, providing a pathway to correlate nanoscale morphology with charge mobility. These results highlight ultrafast IR s-SNOM as a powerful tool for mapping spatiotemporal dynamics, which are indispensable for enabling tunable optoelectronic and polaritonic devices at the nanoscale.

Pre-registration