From Light to Heat: Photothermal Conversion Governs Ultrafast Nonequilibrium Charge Transport in 2D Titanium Carbide MXenes

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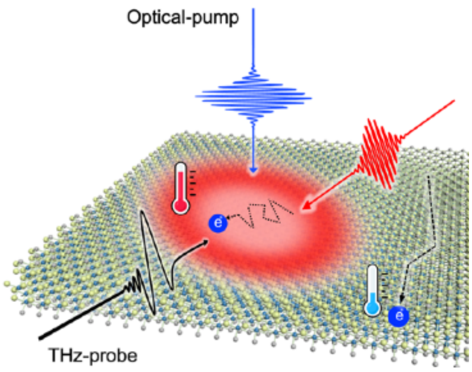
Abstract

Two-dimensional transition metal carbides, known as MXenes, have recently garnered substantial interest as promising candidates for optoelectronic applications due to their exceptional charge mobility[1], tunable properties (via surface terminations), and robust light absorption characteristics. To fully exploit these properties, it is essential to understand the photo-physics and charge transport dynamics of MXenes, in both equilibrium and non-equilibrium states following perturbations (e.g., optical or electrical fields). In the talk, we report an intriguing pump-induced, extremely long-lived (beyond nanosecond), negative photoconductivity using ultrafast terahertz (THz) spectroscopy. In conjunction with the scanning microscopic transient absorption studies, we attribute this effect to unusually long-lived lattice heating effects in MXenes thanks to a combination of relatively low thermal conductivity and extremely high interface thermal resistance [2]. Our findings reveal the nature of the slow thermal relaxation in $Ti_3C_2T_x$ MXenes, providing new insights into the fundamental photophysical processes relevant to MXene-based photon-thermal electronics.



References

1. Wenhao Zheng et.al, *Band Transport by Large Fröhlich Polarons in MXenes*, ***Nature Physics*** 2022, 18, 544-550.
2. Wenhao Zheng et.al, *Photothermal Effects Control Ultrafast Charge Transport in Titanium Carbide MXenes*, ***Nature Communications****, 2025, accepted.*