# Experimental study of excitonic polaron formation in BiOI nanoplatelets

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The interaction between excitons and the lattice in polar semiconductors can lead to the formation of excitonic polarons, which strongly influence the transport and optical properties [1, 2]. Understanding the underlying mechanisms of exciton-phonon coupling is essential for controlling polaronic effects in functional materials. However, direct experimental observation of the ultrafast formation dynamics of excitonic polarons remains challenging. Here, we present a time- and momentum-resolved photoemission electron microscopy (TR-PEEM) study on photoexcited BiOI nanoplatelets with 50 femtosecond time resolution, providing direct access to the conduction band electron dispersion and its temporal evolution in the presence of valence band holes.

During the thermalization and sub-picosecond relaxation of the electron hole pairs, we observe transient changes in the conduction band dispersion, including an increase in the effective mass and an energy shift of approximately 160 meV. We interpret these findings as signatures of excitonic Fröhlich polaron formation, where exciton-lattice interactions renormalize the electronic band structure. The extracted characteristic timescale of less than 200 femtoseconds suggests that an in-plain polaron formation occurs faster than a phonon period, highlighting the rapid coupling between excitons and longitudinal optical phonons. Additionally, a slower energy shift with a time constant of several hundred femtoseconds is observed, which may indicate out-of-plain polaron formation along the stacking direction. These results are compared with previous studies on coherent phonons in BiOI nanoplatelets [3].

The large Fröhlich coupling strength in BiOI, compared to conventional III-V semiconductors, makes it a promising system for studying excitonic polarons.

## References

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