

Optoelectronic Properties of Chiral Perovskites and Devices

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Metal halide perovskites have been successfully integrated into many traditional optoelectronic applications including solar cells, LEDs, and lasing. One of the main benefits of halide perovskites is their structural tunability. This tunability enables the formation of unique structures including chiral perovskites, which typically incorporate a chiral organic cation into a metal-halide network. Chiral perovskites offer the potential to expand the repertoire of perovskite applications because they combine the optoelectronic properties of semiconductors such as high charge-carrier mobility with the properties of chiral materials including spin selectivity. Several devices including emitters and detectors of polarized light have already been demonstrated, although their development is still in its infancy.¹

As the development of chiral perovskites materials is occurring simultaneously with device development, much remains to be discovered about the basic physical and chemical properties of chiral perovskites and how these properties determine device efficiency. Additionally, most studies of basic properties are performed on isolated chiral perovskite films and not fully operating devices. Using ultrafast spectroscopy techniques, the overall goal of this research project will be to perform detailed optoelectronic studies of both chiral perovskite thin films and devices to better understand the mechanisms that limit performance. Additionally, it will survey a range of technologically relevant materials used in the most efficient devices in order to identify the key components to optimize efficiency.

The main experimental focus of the project will be on optical-pump/THz-probe (OPTP) spectroscopy, an ultrafast technique that directly probes mobile charge-carriers and allows for simultaneous determination of the charge-carrier mobility and charge-carrier dynamics on a sub-picosecond timescale.² This technique has proven essential for studying the time-dependent optoelectronic properties of many types of semiconductors including standard halide perovskites and chiral perovskites.³⁻⁴ Additionally, this project will utilize many of the other spectroscopy and microscopy techniques at the university including the resources of the Warwick Centre for Ultrafast Spectroscopy (go.warwick.ac.uk/WCUS) and the Spectroscopy and Microscopy Research Technology Platforms. For specific questions regarding the project, please email Rebecca Milot (Rebecca.Milot@warwick.ac.uk). More information about the Warwick Ultrafast and THz photonics group can be found on our group website: go.warwick.ac.uk/ultrafast.

References

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