Prof Malcolm Kadodwala

Creating and Measuring Chemical Asymmetry with Chiral Light

Chemical asymmetry underpins molecular recognition, biological function, and enantioselective chemistry, yet its measurement and control remain largely constrained by ensemble-averaged, chemically specific methods. In this talk, I will show how chiral light interacting with nanostructured electromagnetic environments can both *measure* and *induce* chemical asymmetry without requiring chemical modification of molecules or materials [1–6]. By exploiting optical chirality, structured light, and emitter–nanophotonic coupling, these approaches enable sensitivities down to the few-molecule and single-emitter regime, while also allowing reversible, optically driven control of chiral responses in otherwise achiral systems. Together, these results establish chiral light as a physical tool for probing and creating chemical asymmetry, with implications for biosensing, quantum-enabled measurement strategies, and sustainable routes to functional materials.

Selected Publications

1. Hendry, E.; Carpy, T.; Johnston, J.; Popland, M.; Mikhaylovskiy, R. V.; Lapthorn, A.; Kelly, S. M.; Barron, L. D.; Gadegaard, N.; Kadodwala, M.
   Ultrasensitive detection and characterization of biomolecules using superchiral fields.
   Nature Nanotechnology 2010, *5*, 783–787.
2. Kelly, C.; Lalaguna, P. L.; Souchu, P.; Gadegaard, N.; Kadodwala, M.
   Controlling the symmetry of inorganic ionic nanofilms with optical chirality.
   Nature Communications 2020, *11*, 5169.
3. Hajji, M.; Karimullah, A. S.; Kumar, R.; Gadegaard, N.; Kadodwala, M.
   A chiral quantum metamaterial for hypersensitive biomolecule detection.
   ACS Nano 2021, *15*, 19905–19916.
4. Lalaguna, P. L.; Souchu, P.; Mackinnon, N.; et al.; Kadodwala, M.
   Spatial control of 2D nanomaterial electronic properties using chiral light beams.
   ACS Nano 2024, *18*, 20401–20411.
5. Kumar, R.; Trodden, B.; Klimash, A.; et al.; Kadodwala, M.
   Electromagnetic enantiomers: Chiral nanophotonic cavities for inducing chemical asymmetry.
   ACS Nano 2024, *18*, 22220–22232.
6. Lalaguna, P. L.; Hashiyada, S.; Gadegaard, N.; Götte, J. B.; Barnett, S. M.; Tanaka, Y.; Kadodwala, M.
   Optical activity modulation in chiral metasurfaces via structured light.
   Nano Letters 2025.

Gardiner Chair
Chemical Photonics Group
University of Glasgow
School of Chemistry
Joseph Black Building
Glasgow, G12 8QQ