Chiral semiconductor nanophotonics

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Chirality plays a pivotal role in the functionality of biomolecules such as proteins, amino acids, and carbohydrates. Circular dichroism can distinguish enantiomers thanks to a small difference in the absorption of circularly polarized light. However, chiral sensing faces significant limitations due to inherently weak chiroptical signals. It is thus severely limited by low sensitivity and low spatial resolution. As a result, it is challenging to resolve the chirality of individual nanoscale objects using light for critical applications such as detecting protein aggregates linked to various diseases.

In this presentation, I will discuss our progress to push the limits of optically resolvable chirality through new concepts in semiconductor nanophotonics. First, I will show several strategies to optimize chiral molecular sensors based on silicon metasurfaces to detect low molecular concentrations. Specifically, I will present our recent results on tailoring silicon nanostructures to enhance polarized fluorescence and Raman spectroscopies, increase optical chirality, and maximize chirality transfer [1,2].

Second, I will introduce an approach to molecular sensing based on excitons in atomically thin semiconductors. I will show how monolayer semiconductors can exhibit strong fluorescence fluctuations [3] that report on charge transfer events to nearby nano-objects.

References

[1] E Mohammadi, A Tittl, KL Tsakmakidis, TV Raziman, AG Curto, ACS Photonics, 8, 6, (2021)1754.

[2] TV Raziman, RH Godiksen, MA Müller, AG Curto, ACS Photonics 6, 10, (2019) 2583.

[3] RH Godiksen, S Wang, TV Raziman, MHD Guimaraes, JG Rivas, AG Curto Nano Lett. 20, 7, (2020) 4829.

Figures

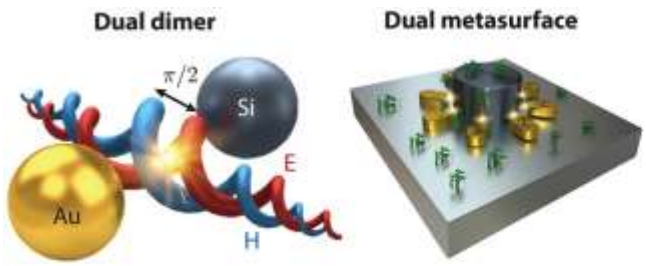

Figure 1: Dual metal-dielectric nanoresonators for chiral sensing

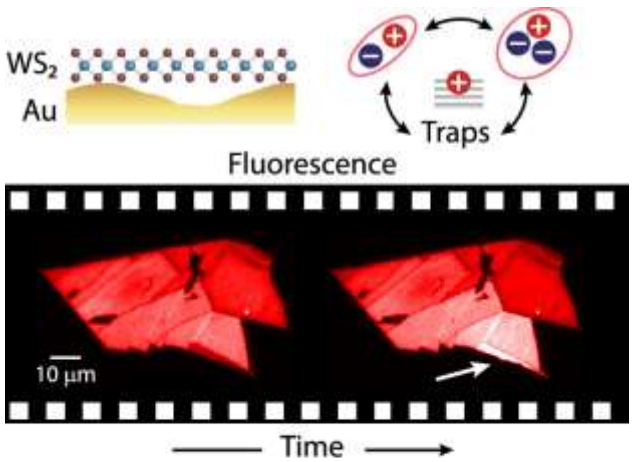

Figure 2: Exciton fluctuations at the interface between a 2D semiconductor and a metal.