Multidimensional imaging reveals mechanisms controlling multimodal label-free biosensing in vertical 2DM heterostructures

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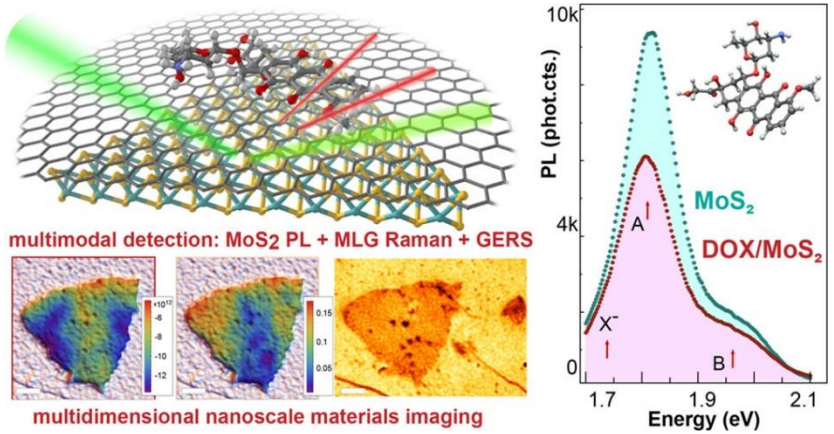
Project Summary: A multi-dimensional optical imaging technique that combines scattering was developed to map subdiffractional distributions of doping and strain in MoS_2 and MoS_2/graphene vertical heterostructures. The variations in doping and strain were correlated to electronic properties and were used to understand the behavior of biosensors fabricated using the 2D material. Optical label-free detection of doxorubicin, a common cancer drug was reported via three independent optical detection channels (photoluminescence shift, Raman shift and graphene enhanced Raman scattering). Non-uniform broadening of the components of the multimodal signal correlated with the statistical distribution of local optical properties of the heterostructure. The results demonstrate the ability of multidimensional nanoscale imaging to reveal the physical origin of a local response and propose a strategy to mitigate materials variability for future fabrication of multiplexed biosensing devices. Published in *ACS Nano* 16, 2598-2607 (2022).

2DCC Role: MoS_2 monolayers grown by MOCVD and CVD graphene samples grown on copper were provided by 2DCC for this study.



Multi-modal optical characterization including photoluminescence (PL), Raman spectroscopy and graphene-enhanced Raman spectroscopy (GERS) were used for detection of doxorubicin adsorption on MoS_2/graphene heterostructures. The results were correlated to local scale electronic and optical properties of the 2D materials as measured by scattering scanning nearfield optical microscopy (sSNOM) and Kelvin probe measurements.