Proximity-induced "magic" Raman bands in TERS spectra of MoS_2 and WS_2 deposited on the 1L h-BN-capped gold

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The nanoscale resolution of tip-enhanced Raman scattering (TERS) makes it a powerful tool to image and identify structural properties and defects in 2D semiconductors. Recently, we proposed an "ideal" substrate for gap-mode TERS and tip-enhanced photoluminescence (TEPL), namely 1L h-BN-capped gold or silver [1], which demonstrated a strong response from a WS_2 monolayer, exfoliated on it. Unexpectedly, in addition to the Raman bands of WS_2, we observed strong narrow bands (at~76 cm^{-1} and ~796 cm^{-1}) that normally do not appear in the normal Raman spectra of neither WS_2 nor h-BN. Since these bands were observed in the same spectral position in the TERS spectra of MoS2@1L h-BN@Au, it can be assumed that they originated from h-BN. In the literature [2,3] a similar effect was observed in the far-field Raman spectra of h-BN-encapsulated WSe_2. However, in our case the dependency on the excitation wavelength of the intensity of the "magic bands" was completely different, strongly resembling the one of the A'/A_{1g} ratio of WS2@Ag [1], with the magic bands disappearing at the excitation laser energy corresponding to A exciton in WS_2. We will here discuss possible origins of these magic bands, as well as the nature of such unexpected excitation wavelength dependence.

References

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[2] C. Jin, J. Kim, J. Suh *et al.*, Nature Physics (2017), 13, 127–131
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Figure

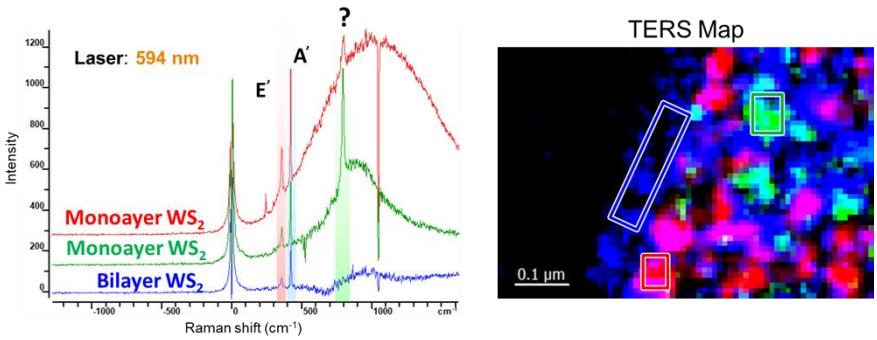

Figure: TERS spectra (left) averaged from a hyperspectral map (right) of WS_2@1L h-BN@Au.