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Raman and PL Spectroscopy of 2D Materials: Resolution Matters

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Abstract

Methods for nanoscale material characterization are in ever-increasing demand, especially those that can provide a broader range of information at once. Near-field techniques based on combinations of scanning probe microscopy (SPM) and Raman or photoluminescence (PL) spectroscopy (tip-enhanced Raman spectroscopy [TERS] and/or tip-enhanced PL [TEPL]) are, thanks to their capabilities and fast development, strong candidates for becoming widespread across the scientific community as SPM and Raman microscopy did only a decade or two ago.

In the present talk, several examples of the utilization of Tip-Enhanced methods will be shown, mostly employed to mono- and bilayer transition metal dichalcogenides (TMDC): (i) gap-less TEPL study of as-grown MoS_2 on silicon with different SiO_2 thickness [1,2], (ii) gapped-mode TERS of MoS_2 mechanically exfoliated on gold layers with varying thickness [3], and (iii) gap-less TEPL of TMDC heterobilayers showing strong localization effects on topographic heterogeneities like blisters and nanobubbles. Additional characterization methods like KPFM, CAFM, NanoXPS, or Spectroscopic Imaging Ellipsometry accompanied the TEPL/TERS to gain further insights into the optoelectronic and crystal structure of the studied samples.

References

[1] A. Rodriguez, T. Verhagen, M. Kalbac, J. Vejpravova, O. Frank, Phys. Status Solidi RRL 13 (2019), 1900381.
[2] T. Verhagen, A. Rodriguez, M. Vondráček, J. Honolka, S. Funke, M. Zlámalová, L. Kavan, M. Kalbac, J. Vejpravova, O. Frank, ACS Appl. Nano Mater. 3 (2020) 6563.
[3] M. Velický, A. Rodriguez, M. Bouša, A. V. Krayev, M. Vondráček, J. Honolka, M. Ahmadi, G. E. Donnelly, F. Huang, H. D. Abruña, K. S. Novoselov, O. Frank, J. Phys. Chem. Lett. 11 (2020) 6112.

Figures

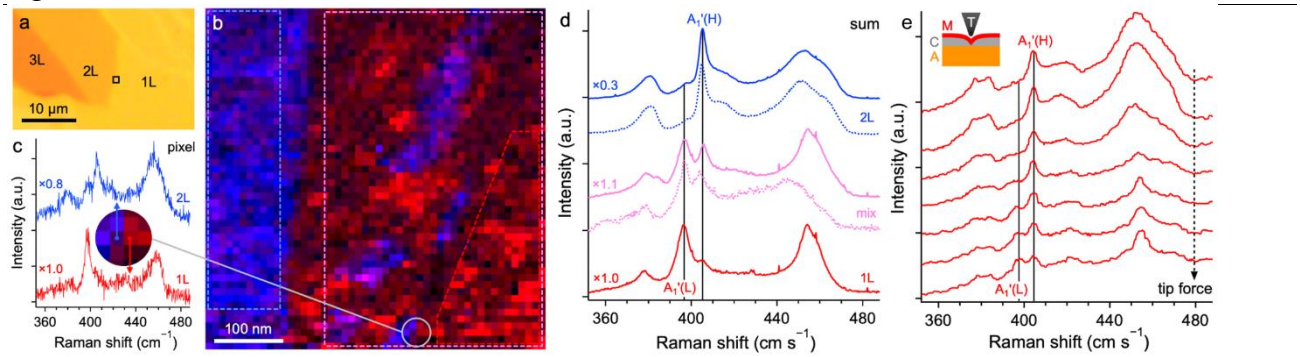

Figure: Tip-enhanced Raman spectroscopy of MoS_2 on Au. (b) TERS intensity map of $A_1'(L)$ (red), $A_1'(H)$ (blue), mixed (magenta). (c) Single-pixel (10×10) nm^2 TERS of adjacent strongly (S) and weakly (W) interacting 1L MoS_2. (d) TERS summed over the weakly interacting 2L (W−2L), strongly interacting 1L (S), and mixed regions (S+W). (e) TERS acquired with a variable tip force. Modified after [3].