High-Speed Automatic Raman Imaging of Suspended Carbon nanotubes with Supervised Machine Learning

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High-speed optical characterization of nanomaterials at low costs is critical for technology transfer of nanoscale devices[1]. Here we demonstrate the automation of high speed carbon nanotubes (CNTs) detection and localization on prong-like substrates[2] with automatic Raman imaging and supervised machine learning (SML) [3]. A strategy for an automatic Raman imaging of suspended CNTs[4] on comb-like silicon substrate is investigated. A two-lines’ (TL) Raman scan is implemented to explore the presence and the orientation of CNTs on the growth substrate. An optical analysis speed of up to 680 prong pairs/hour was demonstrated. We show that SML can be used to build robust predictive models for CNTs (G peaks) monitoring with a high accuracy of 97.5%. This work will explore the speed limit of optical characterization by combing the high-speed Raman imaging strategies and SML approach.

References

Figures

Figure 1: A strategy of high-speed Raman imaging. (a) Schematic strategy of TL Raman scan of suspended CNTs on comb-like silicon substrate (dark blue). (b) TL Raman scan to explore the presence and the orientation of CNTs.

Figure 2: Raman data analysis with SML. (a) Training process with 15000 labelled spectra. An accuracy of 97.5% was achieved after 12000 iterations. (b) An example of classification with a Raman line data showing there is a CNT presence. The upper inset shows a Raman line scan image determined from the intensity of the G band as a function of sample location.