Recent developments in STEM spectroscopy for probing electronic and optical properties of semiconducting materials and nanostructures

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Scanning electron microscopy (STEM) and associated imaging and spectroscopic modes is a very powerful and versatile technique for providing structural, chemical and electronic information of materials with very high spatial resolution. Recently the electron microscopy community has enjoyed great successes in STEM aberration correction and electron-beam monochromation for Electron Energy-Loss Spectroscopy (EELS). Atomically-resolved spectroscopy is now “routinely” achieved and a new access to a full range of optical excitations such as phonons, plasmons or excitons is provided. More exciting applications are emerging from the combination and correlation of fast electron beams with photon beams, providing a high-spatial-resolution alternative to more conventional optical techniques.

Recently, the advent of highly sensitive time-resolved detectors has paved the way for time-resolved experiments and the development of experiments involving the coincidence of electrons and photons (emitted or injected).These new opportunities will be illustrated through several examples such as: detection of point defects in two-dimensional materials (h-BN), observation of the nanoscale modification of excitonic emission in transition-metal dichalcogenides, observation of the dynamics of domain-wall motion, nanothermometry experiments, measurement of de-excitation pathways in materials and development towards the measurement of chiral effects in plasmonic nanostructures.