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IT-12-P-3198 Detecting the topographic, chemical and magnetic contrasts with nanometer spatial resolution

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During the last decades, magneto-imaging techniques based on the analysis of secondary electrons helped the discovery of many interesting phenomena related to magnetic-domain patterns, such as re-entrant topological transitions. For those studies, a typical spatial resolution of some tens of nm, achieved e.g. in Scanning-Electron-Microscopy with Polarization Analysis (SEMPA), was more than enough. Nowadays, the quest to resolve magnetic textures in direct space at atomic scale is triggered by novel fundamental and applicative issues. Domain walls, in relation to their potential use in spintronic devices, represent one example. Inspired by the Russel Young topografiner we redesigned the SEMPA setup by replacing the primary electron beam source and the probing method. We dubbed this new technique Near Field-Emission Scanning Electron Microscopy (NFESEM). In NFESEM the sample surface is typically investigated by scanning at constant height with a primary electron beam energy in the range between 20eV and 100eV. A suitable detector analyzes secondary electrons scattered by the surface. We present the resolution improvement on topographic mapping of Fe-patches evaporated on W(110) substrate (Figure 1) and advances in energy analysis of secondary electrons (Figure 2). Moreover, we report on recent efforts to endow NFESEM with the polarization analysis of the detected secondary electrons that emphasize the true potential of this new technique. In particular, the characteristic spatial resolution and the sizeable secondary electrons yield (see Figures 1 and 2) support the technical feasibility of electron spectroscopy and magnetic-domain mapping at nanometer scale with NFESEM.

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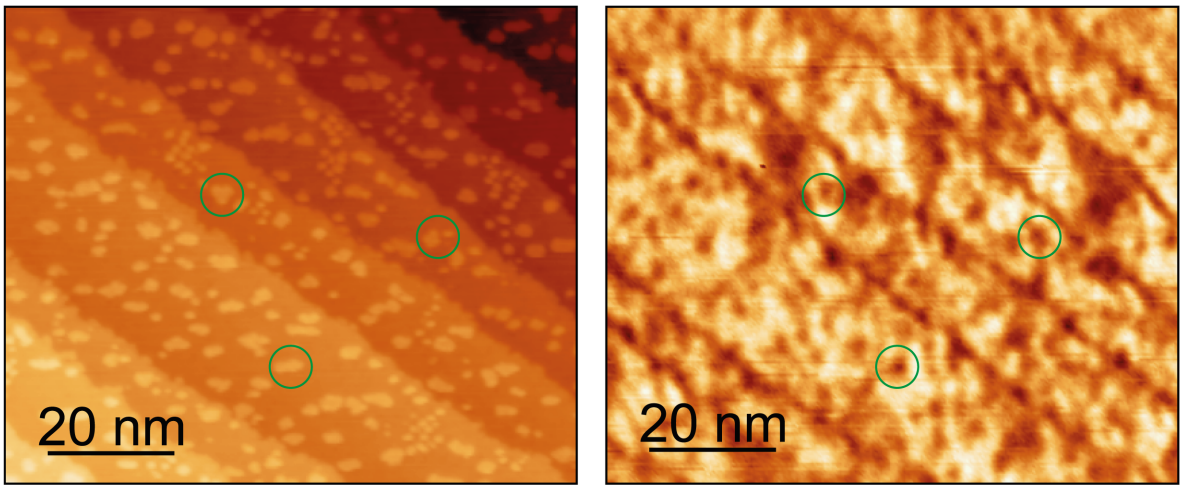

Fig. 1: (Left) STM Map of 0.4 atomic layers of FE on stepped W(110), showing atomic Fe-patches (bright) residing on the terraces and decorating the steps. (Right) The same surface spot recorded in NFESEM mode. Although the Fe-patches are on top of the W-substrate they appear darker - both the patches on the terraces and along the steps.

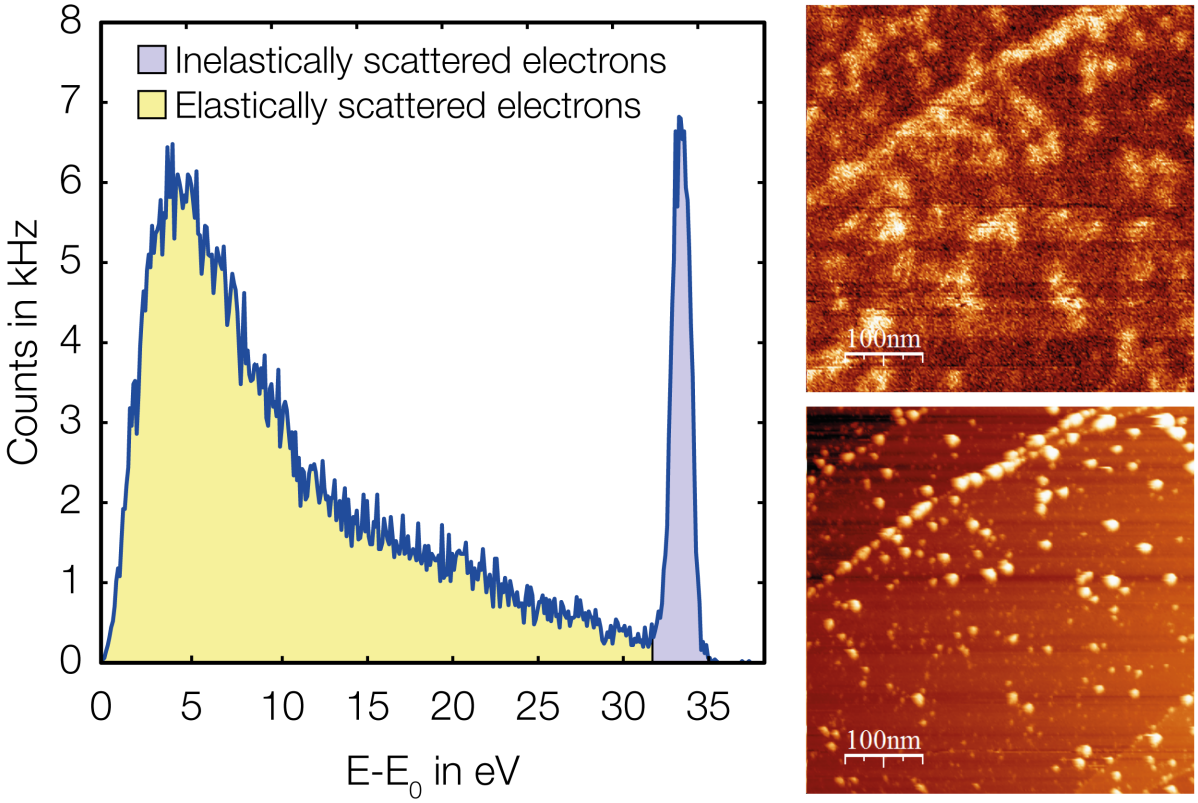

Fig. 2: (Left) Energy spectrum of a GaAs(110) surface for a tip-sample distance of 100 nm, both the secondary electron cascade an the elastic peak are clearly distinguishable. (Top right) Map of a GaAs(110) decorated surface produced by secondary electrons with 13 eV energy for a tip-sample distance of 12 nm. (Bottom right) STM reference image.