In situ off-axis electron holography of electrostatic potentials in working devices in the TEM

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The technique of off-axis electron holography in the transmission electron microscope (TEM), in combination with *in situ* electrical biasing, is a powerful tool for measuring the local electrostatic potential within and around a specimen with nm spatial resolution. It is useful for studying the effects of dopants and defects on electronic transport, resistive switching phenomena in both valence change and phase change materials [1], electron field emission, battery materials, electrical breakdown and sintering, as well as for studying the electric fields around atom probe tomography (APT) needles.

We have used electron holography and related *in situ* TEM techniques to study:

1) Resistive switching in thin films and nanoparticles of oxides (FIG.1, left);
2) Breakdown and current-induced mass transport in InAs nanowires (FIG.1, middle);
3) Electrostatic potentials around electricall biased field emitters and atom probe needles (FIG.1, right) [2].

We are also developing a method based on double exposure electron holography for studying time-resolved electromagnetic phenomena. The basis of the method and its future prospects will be discussed.

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References

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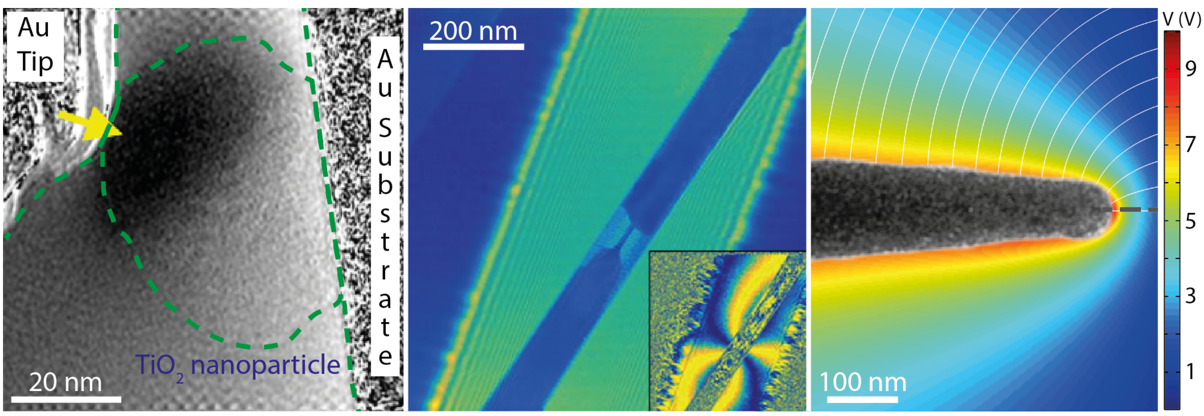

FIG.1 (left) Measured projected electrostatic potential of a TiO_2 nanoparticle recorded during resistive switching *in situ* in the TEM. The yellow arrow indicates a minimum in potential at the interface between the nanoparticle and a gold counter-electrode. (middle) Electron hologram and projected electrostatic potential (inset) of a nanowire recorded during electric-current-induced mass transport, when a “bridge” forms in the middle. (right) Slice through a three-dimensional electrostatic potential recorded from an electrically biased APT needle on the assumption of cylindrical symmetry (shown as an overlaid amplitude image).