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Atomic Resolution STEM-EELS Study of Transition Electronic Localization State Induced by Strain.

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Electronic localization in disordered systems is among the most interesting phenomena in condensed matter physics. Depending on the amount, kind of disorder and dimensionality [1], there are two types of localization, classical Anderson localization (AL) and weak localization (WL). The origin of the AL is multiple scattering interference of the waves due to the randomness in the potential, thus altering the nature of the wave functions [2], while WL typically occurs in disordered electronic systems at very low temperatures. Although the WL is generally regarded as a precursor of the AL transition, the underlying physics of this phenomena is not fully understand yet.

To study the transition between weak and strong localization, we synthesize high-quality ZrO_2 nanopillars with controlled dimensionality embedded in epitaxial $La_{2/3}Sr_{1/3}MnO_3$ (LSMO)/$LaAlO_3$ [110] using state-of-art pulsed laser epitaxy. This peculiar nanostructured system offers a great flexibility to manipulate the superficial structural disorder along the interface by controlling the size of ZrO_2 nanopillar, thus strongly affects the electronic transport of the LSMO matrix.

To characterize this superstructure and demonstrate the precise control of its electronic properties, we performed a combined study of Electron Energy Loss Spectroscopy (EELS) with the Z-contrast high angle annular dark field (HAADF) imaging technique in the scanning transmission electron microscope (STEM) Nion UltraSTEM 200, a unique tool that allow us to obtain simultaneously composition, chemistry and structure of materials with atomic resolution and sensitivity. These techniques, together with geometric phase analysis allow us to determine the spatial distribution of the epitaxial strain across the samples and clarify its impact on the various electronic localization mechanisms.

References:

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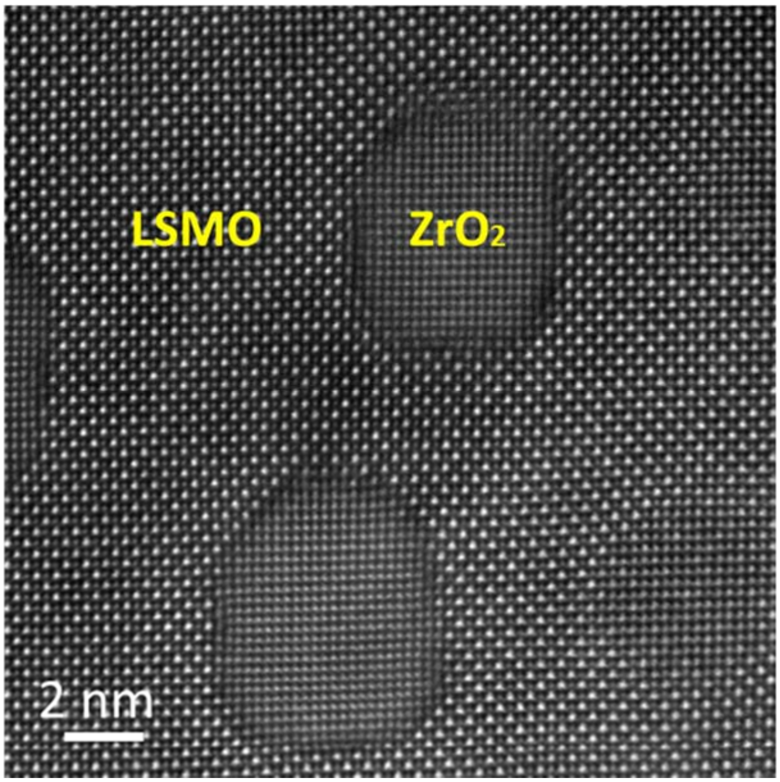

Figure 1. High resolution high angle annular dark field planar view image showing the lattice inside and outside of the ZrO_2 circular pillars embedded in LSMO.