Strongly strained VO_2 thin film growth

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Vanadium dioxide has a temperature-driven metal-semiconductor transition at 68 °C (bulk). There has been a lot of interest in the workings of this transition, which has been explained as either a Mott- or Peierls-transition or a collaborative effect of both. [1] The role of the lattice in the transition is exploitable by strain-engineering VO2, e.g. using epitaxial strain in thin film growth, to increase or decrease the transition temperature and thus facilitate applications in technology.
We grow VO_2 on RuO_2 with the rutile *c* axis in-plane by means of reactive MBE and using atomic oxygen from a thermal cracker. Because of the very large lattice mismatch of 8.1 %, a large tensile strain is expected that would increase the transition temperature beyond the previously reported range. [2] We first verified the VO_2 stoichiometry through locally resolved XAS and analyzed the surface lattice in µLEED at the SPELEEM installed at the CIRCE beamline of the ALBA Synchrotron in Barcelona. This was done on a Ru(0001) substrate where differently oriented RuO_2 islands were grown simultaneously as "virtual substrates". LEED shows that VO_2 grows relaxed on RuO_2(100) but pseudomorphic on RuO_2(110), where it also features a previously not reported (2×2) reconstruction. [3] The reconstruction is attributed to the atomic-oxygen-induced oxygen termination of the film; we confirm this by reproducing VO_2(110)-(2×2) on TiO_2(110) substrates, also using atomic oxygen.

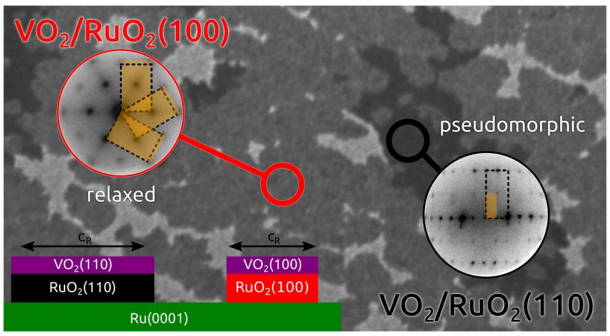

Figure 1. Two locally obtained LEED images of VO_2/RuO_2(100) (32.0 eV) and VO_2/RuO_2(110) (34.5 eV) showing relaxed and pseudomorphic growth, respectively. The background consists of a LEEM image (10.4 eV) of the same sample state. [3]

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References
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