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Straining to observe the M2 phase in epitaxial VO_2 films[1]

NICHOLAS QUACKENBUSH, MATTHEW WAHILA, LOUIS PIPER, Dept. of Physics, Binghamton University, HANJONG PAIK, MEGAN HOLTZ, XIN HUANG, JOEL BROCK, DAVID MULLER, DARRELL SCHLOM, Dept. of Materials Science and Engineering, Cornell University, JOSEPH WOICIK, Materials Science and Engineering Laboratory, National Institute of Standards and Technology, DARIO ARENA, Dept. of Physics, University of South Florida — It has been more than a decade since it was shown that the transition temperature T_{MIT} of VO_2 in epitaxial thin films can be tuned by compressive and tensile strain along the rutile c-axis. Since this discovery, uniaxial strain studies of VO_2 nanobeams have demonstrated that compressive strain indeed lowers T_{MIT}, thus stabilizing the metallic rutile phase. However, even minor tensile strain induces an intermediate insulating monoclinic M2 phase. Whether this phase can be stabilized in thin films remains contentious owing to the constraints of sample and/or interface quality. Here, we present hard x-ray photoelectron spectroscopy and temperature-dependent soft x-ray absorption spectroscopy of high quality ultrathin epitaxial VO_2 films on TiO_2 (001) and (100) substrates. The VO_2/TiO_2(001) are absent of intermediate phases and maintain a MIT similar to unstrained VO_2, while the VO_2/TiO_2(100) films display a stable M2 phase between the M1 and rutile endpoint phases. We discuss our findings in terms of differences between uniaxial and biaxial strain.

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