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Temperature dependence of the optical properties of VO_2 deposited on sapphire with different orientations MOHAMMAD NAZARI, YONG ZHAO, VLADIMIR KURYATKOV, ZHAOYANG FAN, AYRTON BERNUSSI, MARK HOLTZ, Texas Tech University, PHYSICS DEPARTMENT AND NANO TECH CENTER OF TEXAS TECH UNIVERSITY TEAM — Vanadium dioxide exhibits a reversible first-order metal-insulator phase transition (MIT) at temperature $T_{MIT} = 350$ K. The transformation brings structural phase transition and abrupt changes in electrical conductivity and optical properties. Despite intensive studies of this material, little is understood about the optical properties and their connection with the structural properties across the phase transition. We report spectroscopic ellipsometry and Raman investigations of the optical properties of vanadium dioxide on sapphire substrates with $c-$, $m-$ and $r-$ orientations. For the $m-$ and r-plane substrates, VO_2 is strained such that the material transforms from the monoclinic M_1 phase directly to the rutile R structure. In contrast, c-plane sapphire produces strains favoring transformation from M_1 into monoclinic M_2 material, prior to reaching the R phase. These structural differences result in distinct variations of the optical transitions observed in the ellipsometry results. While in m-plane sample the energy gap collapses over a narrow temperature range, for the c-plane case, a broad temperature range is obtained over which the energy gap is small but not fully collapsed. Raman studies show diverse phonon behavior across the phase transitions.

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