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Two-photon Photoemission Electron Microscopy Imaging of TiO₂

GANG XIONG, ALAN JOLY, WAYNE HESS, S. CHAMBERS, T. KASPAR, KENNETH BECK, Pacific Northwest National Laboratory, P O Box 999, Richland, WA 99352, USA — Photoemission electron microscopy (PEEM) utilizing two-photon excitation was used to image a novel TiO₂ thin film sample grown by molecular beam epitaxy. The TiO₂ thin film consists of small (50-100 nm) TiO₂ rutile nanocrystallites embedded in an epitaxial anatase TiO₂ film. Individual rutile crystallites can be identified from the anatase background, in part due to the work function difference and morphology contrast. For both phases the photoelectron signals result from electrons at the surface defect levels in the gap rather than valence band electrons. We compare the two-photon PEEM images excited by p- and s-polarized light. The greater image intensity excited by p-polarized light can be attributed to a stronger refracted wave and is further enhanced by the two-photon effect. How the differences in optical refraction, absorption and photoelectron yield affect the contrast between rutile nanocrystallites and anatase background is discussed. We summarize the contrast mechanisms for PEEM imaging and discuss the role of the complex dielectric constant in PEEM contrast mechanisms. Enhanced photoemissions from localized regions are also discussed.

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