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Tunable layer-by-layer oxidation of atomically thin WSe_2

MAHITO YAMAMOTO, WPI Center for Materials Nanoarchitechtonics (WPI-MANA), National Institute for Materials Science, Tsukuba, Ibaraki 305-0044, Japan, MICHAEL FUHRER, CNAM, University of Maryland, College Park, Maryland 20742-4111 and School of Physics, Monash University, Melbourne VIC 3800, Australia, KEIJI UENO, Department of Chemistry, Graduate School of Science and Engineering, Saitama University, Saitama 338-8570, Japan, KAZUHITO TSUKAGOSHI, WPI Center for Materials Nanoarchitechtonics (WPI-MANA), National Institute for Materials Science, Tsukuba, Ibaraki 305-0044, Japan — Growing a high-quality oxide film with a tunable thickness on atomically thin transition metal dichalcogenides is of great importance for the electronic and optoelectronic applications. Here we demonstrate homogenous surface oxidation of atomically this WSe_2 with a self-limiting thickness from single- to tri-layers. Atomically thin WSe_2 films were mechanically exfoliated from bulk crystals onto SiO_2 and exposed to ozone at various temperatures. Below 100 °C, the ozone treatment results in lateral growth of tungsten oxide islands on WSe_2, forming a uniform film on top. However, the oxidation does not progress to the underlying layers. At 200 °C, the surface layers are oxidized in the layer-by-layer regime, up to trilayers. We find, by using Raman and photoluminescence spectroscopy, that underlying single-layer WSe_2 is decoupled from the top oxides. These observations have important implications for applications of the oxide film in electronic devices, such as a tunnel barrier and a gate dielectric.

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