Supplementary Information for

Growth of vanadium dioxide thin films on hexagonal boron nitride flakes as transferrable substrates

Shingo Genchi¹, Mahito Yamamoto¹,*, Koji Shigematsu², Shodai Aritomi³, Ryo Nouchi⁴,⁵, Teruo Kanki¹, Kenji Watanabe⁶, Takashi Taniguchi⁶, Yasukazu Murakami²,³ & Hidekazu Tanaka¹,*

¹Institute of Scientific and Industrial Research, Osaka University, Ibaraki, Osaka 567-0047, Japan

²The Ultramicroscopy Research Center, Kyushu University, Fukuoka 819-0395, Japan.

³Department of Applied Quantum Physics and Nuclear Engineering, Faculty of Engineering, Kyushu University, Fukuoka 819-0395, Japan.

⁴Graduate School of Engineering, Osaka Prefecture University, Sakai, Osaka 599-8570, Japan

⁵JST PRESTO, Kawaguchi, Saitama 332-0012, Japan

⁶National Institute for Materials Science, Tsukuba, Ibaraki 305-0044, Japan

*Correspondence and requests for materials should be addressed to M.Y. (mahito.yamamoto@sanken.osaka-u.ac.jp) or H.T. (h-tanaka@sanken.osaka-u.ac.jp)
Figure S1. AFM image of VO$_2$ grown on Al$_2$O$_3$(0001) by PLD, showing the formation of the nanometer-scale grains. The scale bar is 200 nm. The grain size is estimated to be 20-30 nm in length.
Figure S2. (a) Cross-sectional STEM image of the VO$_2$/hBN stack and (b) the FFT image extracted from the entire VO$_2$ region. The VO$_2$ film is observed to be oriented along the [110] direction of the rutile structure. The STEM image can be identified to be the projection of the [001] direction of the rutile structure, corresponding to the [20̅1] projection of the monoclinic structure. (c) Cross-sectional STEM image of the VO$_2$/hBN stack obtained from the different specimen from one in (a). (d and e) FFT images obtained from the regions surrounded by the dashed green (Region A) and light-blue (Region B) lines the STEM image in (c). The Moiré patterns are clearly observed in the regions A and B.
Figure S3. Optical images of the VO$_2$/hBN stacks transferred onto (a) a glass slide, (b) a gold (Au) film, and (c) a weighing paper. The scale bars are 10 µm. (d) Raman spectra of the stacks on the glass slide (black curve), Au (red curve), and the paper (blue curve). The prominent peaks of VO$_2$ are observed for all the samples, suggesting that the crystallinity of the VO$_2$ films are retained after the transfer process.