Supporting information

# Mechanistic Understanding of Tungsten Oxide In-Plane Nanostructure Growth via Sequential Infiltration Synthesis

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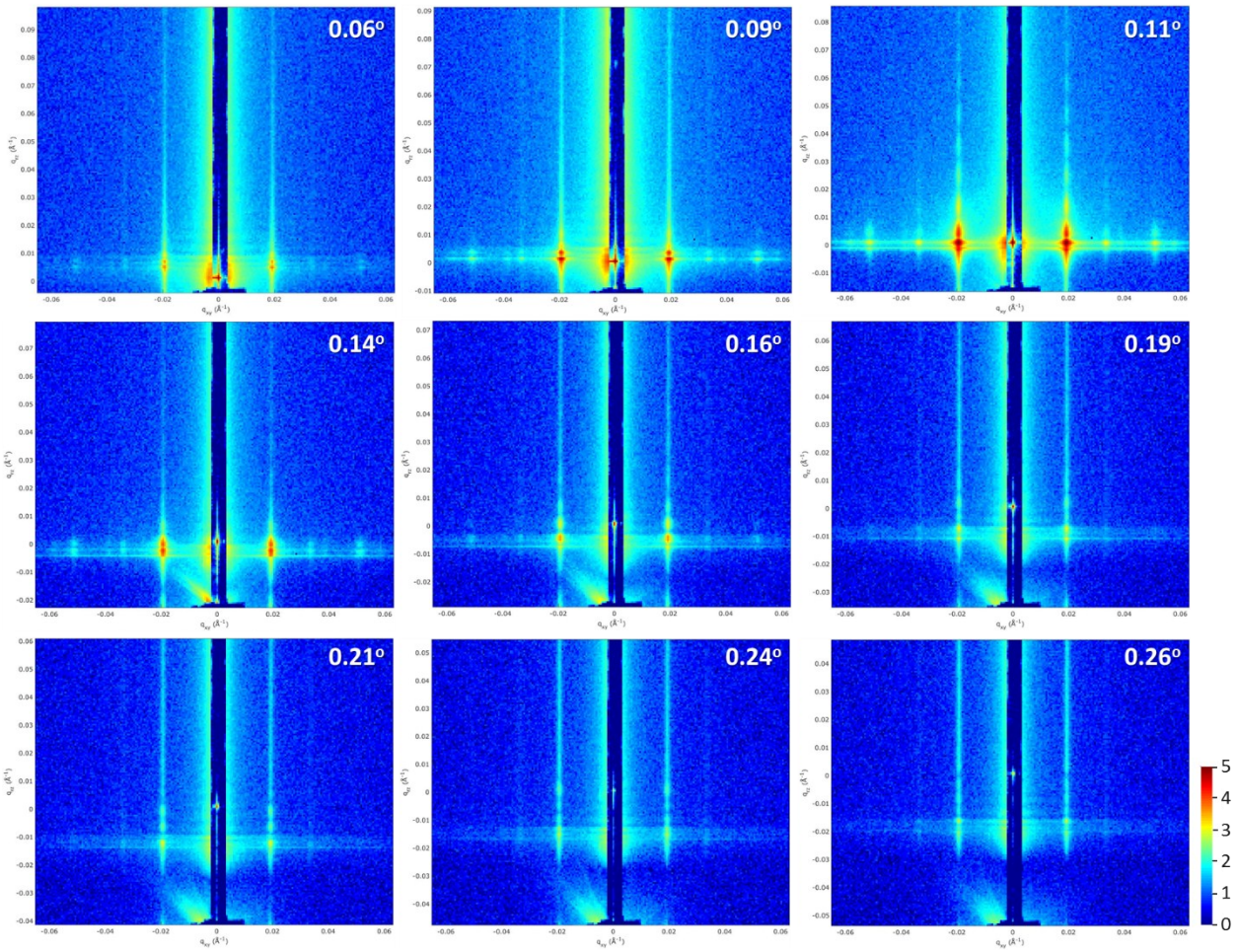


**Figure S1** Grazing-incidence small-angle X-ray scattering (GISAXS) patterns from as-prepared self-assembled block copolymer (BCP) film of poly(styrene-*block*-methyl methacrylate (PS-*b*-PMMA) with $M_n$ = 46k/21k used as a template. The incident angle ($\alpha_i$) of X-ray beam against the films was scanned from 0.06° to 0.26° as shown in the inset. The x and y axes are $q_{xy}$ and $q_{r,z}$, respectively.

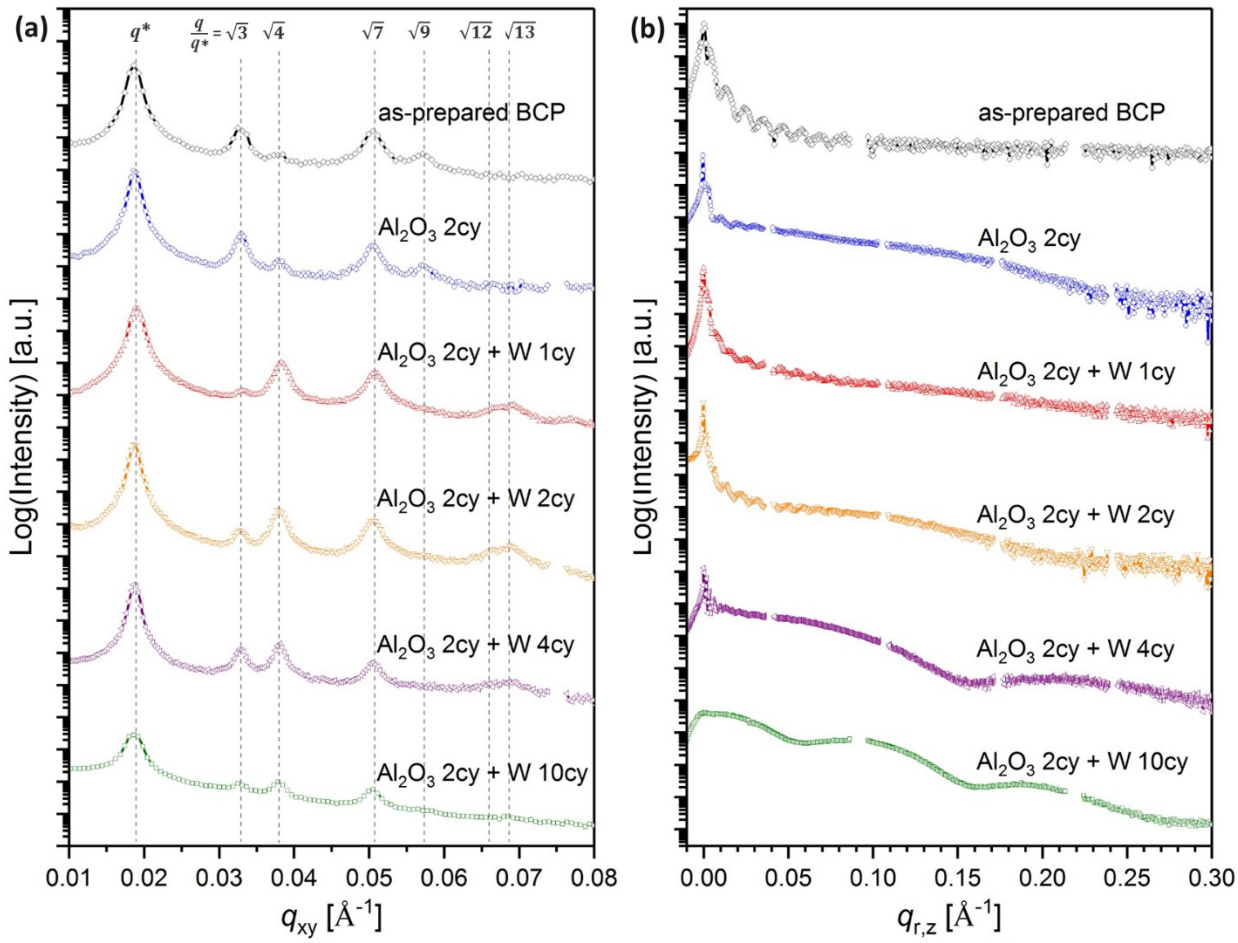


**Figure S2** (a) In-plane and (b) out-of-plane line profiles of GISAXS data (displayed at Figure 2 in the main text) for as-prepared BCP film and samples after sequential infiltration synthesis (SIS) of $Al_2O_3$ seed (2 cycles) and subsequent W SIS deposition (1, 2, 4 and 10 cycles). The incident angles ($\alpha_i$) of the X-ray beam with respect to the film surface plane were 0.10° – 0.11° as indicated at Figure 2 in the main text. In-plane and out-of-plane line profiles were extracted along the $q_{xy}$ direction near the reflected direct beam and the $q_{r,z}$ direction at the primary diffraction peak, respectively. Self-assembled BCP film of PS-*b*-PMMA with $M_n$ = 46k/21k was used as a template.

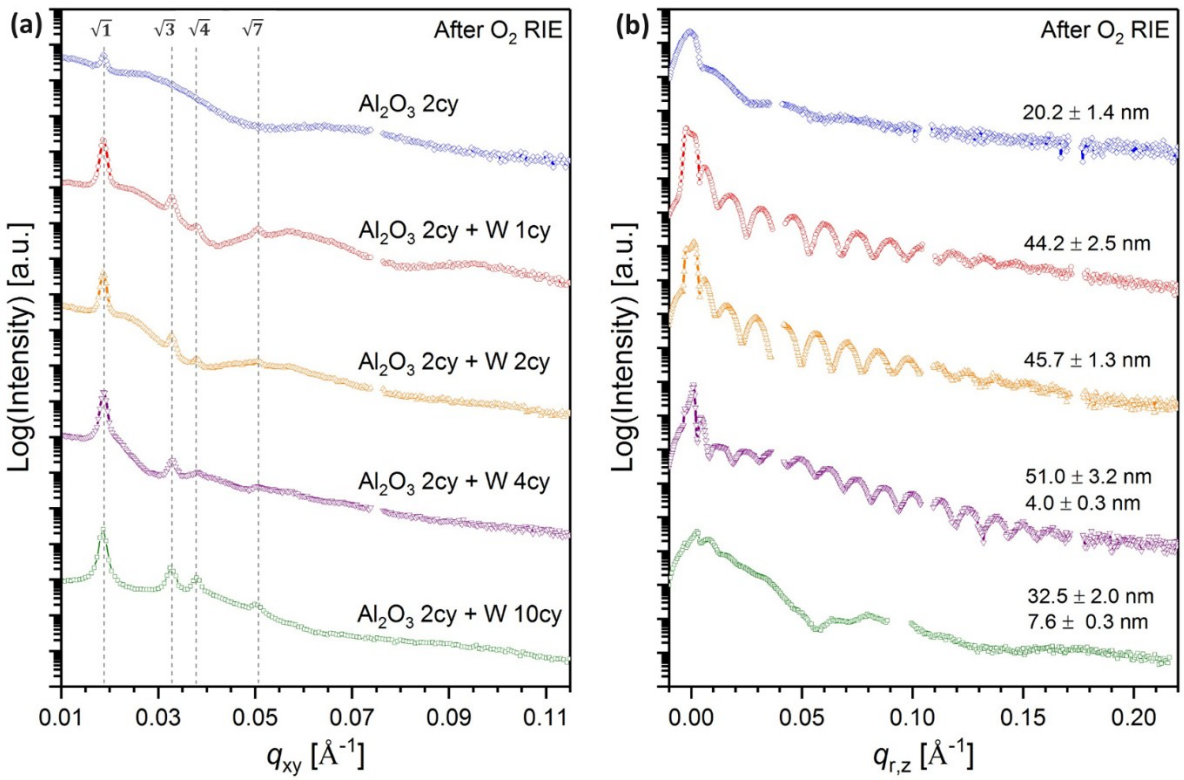


**Figure S3** (a) In-plane and (b) out-of-plane line profiles of GISAXS data (displayed at Figure 3) for nanostructured samples after $Al_2O_3$ seed SIS (2 cycles) and following W SIS deposition (1, 2, 4 and 10 cycles) and subsequent $O_2$ reactive ion etching (RIE). The incident angles ($\alpha_i$) of X-ray beam against the films were 0.09° – 0.10°. In-plane and out-of-plane line profiles were extracted along the $q_{xy}$ direction near the reflected direct beam and the $q_{r,z}$ direction at the primary diffraction peak, respectively. The film thicknesses extracted from out-of-plane line profiles are listed in (b). Self-assembled BCP film of PS-*b*-PMMA with $M_n$ = 46k/21k was used as a template.

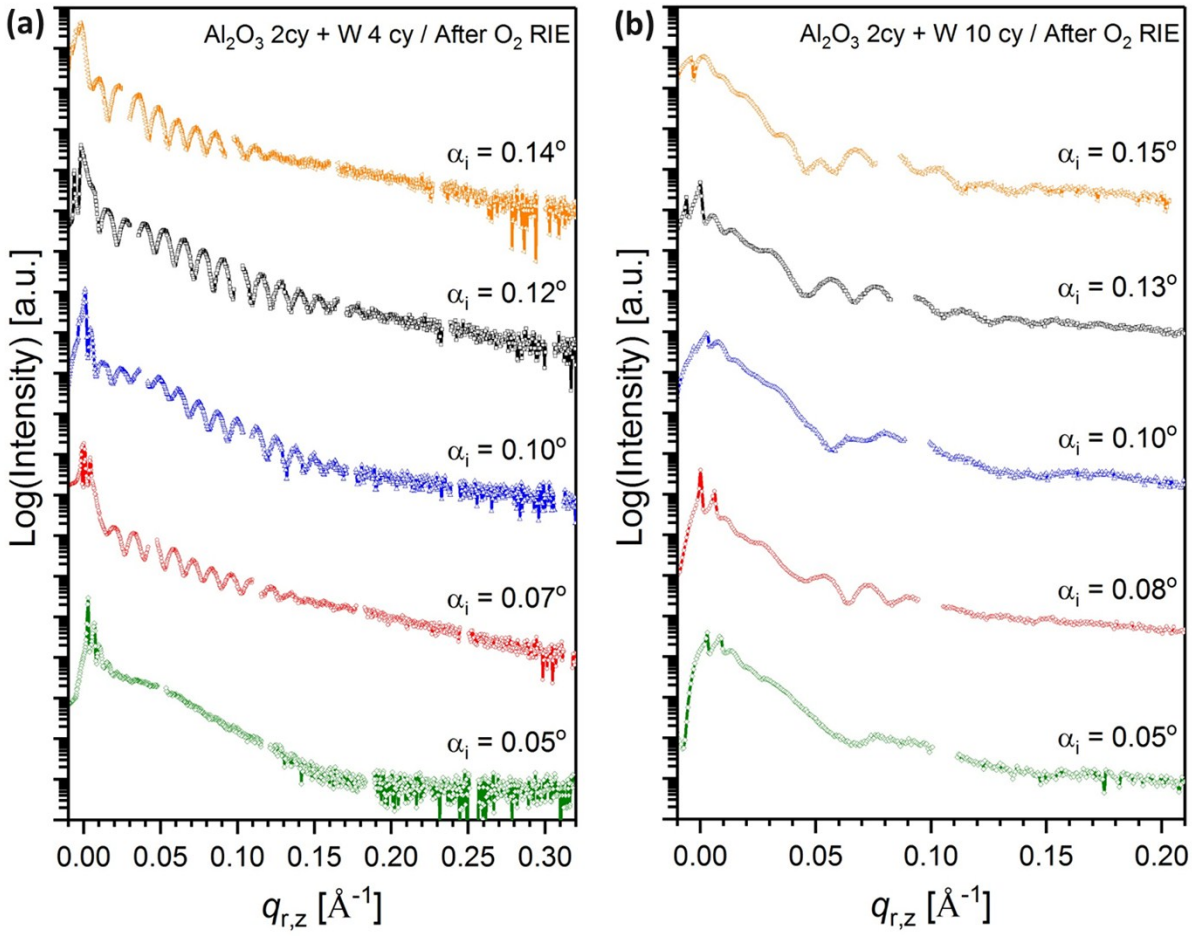


**Figure S4** Out-of-plane line profiles of GISAXS data for nanostructured samples after $Al_2O_3$ seed SIS (2 cycles), then W SIS (a) 4 cycles and (b) 10 cycles, and subsequent $O_2$ RIE. The incident angle ($\alpha_i$) of X-ray beam against the films was scanned from 0.05° to 0.15°. Profiles were extracted along the $q_{r,z}$ direction at the primary diffraction peak. Self-assembled BCP film of PS-*b*-PMMA with $M_n$ = 46k/21k was used as a template.

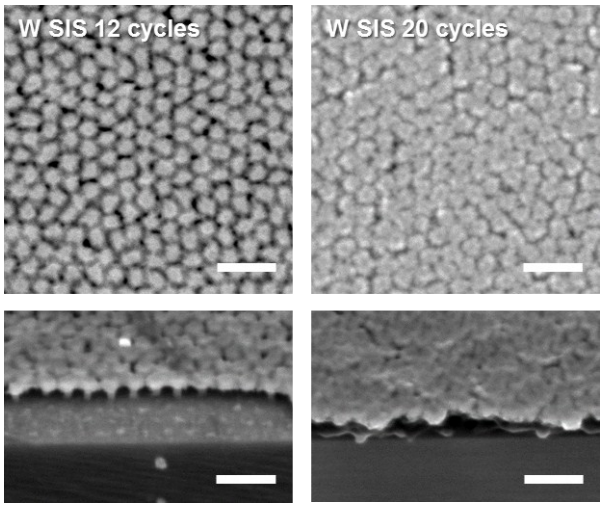


**Figure S5** Plan-view / cross-sectional Scanning electron microscopy images of the samples prepared by $Al_2O_3$ SIS 2 cycles and W SIS 12 and 20 cycles and subsequent $O_2$ RIE, respectively. The inset scale bars indicate 100 nm. Self-assembled BCP film of PS-*b*-PMMA with $M_n$ = 46k/21k was used as a template.

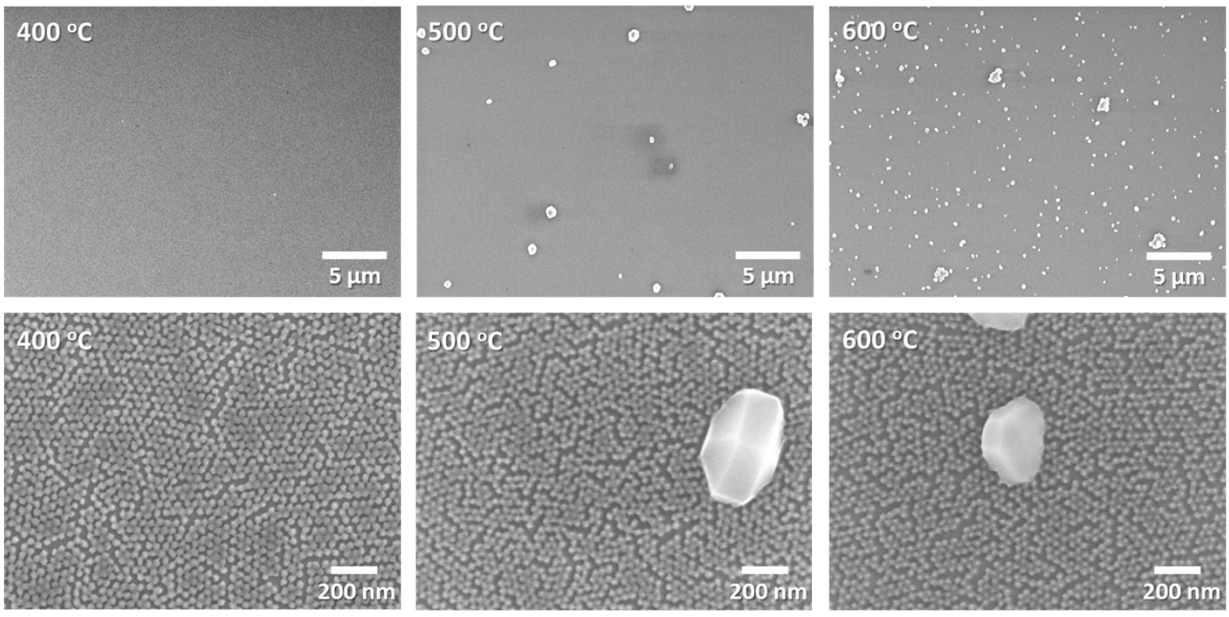


**Figure S6** Scanning electron microscopy (SEM) images of the samples prepared by $Al_2O_3$ SIS 2 cycles and W SIS 10 cycles and subsequent $O_2$ RIE, then lastly annealed at 400 °C, 500 °C and 600 °C in air for 3 hours, respectively. Self-assembled BCP film of PS-*b*-PMMA with $M_n$ = 46k/21k was used as a template.