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 (α_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 Al₂O₃ seed (2 cycles) and subsequent W SIS deposition (1, 2, 4 and 10 cycles). The incident angles (αᵢ) 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 qₓᵧ direction near the reflected direct beam and the qᵣᶻ 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 Al₂O₃ seed SIS (2 cycles) and following W SIS deposition (1, 2, 4 and 10 cycles) and subsequent O₂ reactive ion etching (RIE). The incident angles (αᵢ) 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-ₜPMMA with $M_n = 46k/21k$ was used as a template.
Figure S4 Out-of-plane line profiles of GISAXS data for nanostructured samples after Al₂O₃ seed SIS (2 cycles), then W SIS (a) 4 cycles and (b) 10 cycles, and subsequent O₂ RIE. The incident angle (αᵢ) of X-ray beam against the films was scanned from 0.05° to 0.15°. Profiles were extracted along the qᵣz direction at the primary diffraction peak. Self-assembled BCP film of PS-b-PMMA with Mₙ = 46k/21k was used as a template.
Figure S5 Plan-view / cross-sectional Scanning electron microscopy images of the samples prepared by Al₂O₃ SIS 2 cycles and W SIS 12 and 20 cycles and subsequent O₂ RIE, respectively. The inset scale bars indicate 100 nm. Self-assembled BCP film of PS-ₐ-PMMA with Mₙ = 46k/21k was used as a template.

Figure S6 Scanning electron microscopy (SEM) images of the samples prepared by Al₂O₃ SIS 2 cycles and W SIS 10 cycles and subsequent O₂ RIE, then lastly annealed at 400 °C, 500 °C and 600 °C in air for 3 hours, respectively. Self-assembled BCP film of PS-ₐ-PMMA with Mₙ = 46k/21k was used as a template.