**Supplementary Figure S1** – AES depth profile of tungsten deposited by ALD. An aluminum oxide nucleation layer was deposited by ALD before tungsten deposition. Silicon was used as a substrate.

**Supplementary Figure S2** – XRD pattern of a tungsten coated colloidal crystal. This data was collected after annealing at 1,000 °C for 12 hours. As deposited, the tungsten material was amorphous.
Supplementary Figure S3 – Tungsten coated colloidal crystal after annealing to 1,400 °C. This SEM micrograph is a fracture cross-section showing the complete structural degradation of a tungsten coated colloidal crystal after annealing to 1,400 °C for 1 hour. Scale bar, 1 µm.

Supplementary Figure S4 – Tungsten inverse colloidal crystal reflectance after annealing. Reflectance data were collected after annealing a tungsten inverse colloidal crystal at 1,000 °C for 12 hours (dashed red line) and then subsequently annealing at 1,400 °C for 1 hour (solid red line).
Supplementary Figure S5 – Reflectance spectrum of a tungsten flat film. The measured flat tungsten film was deposited on a sapphire substrate using the same conditions described for photonic crystal fabrication. For consistency, a thin layer of aluminum oxide (10 nm) was first deposited by ALD on the sapphire substrate. This sample was annealed at 1,000 °C for 12 hours, prior to the reflectance measurement.

Supplementary Figure S6 – Schematic of the emissometer. a Emissometer configured for collection of thermal emission from a heated sample in the vacuum chamber. b Emissometer configured for collection of thermal emission from the black body reference source.
Supplementary Figure S7 – Schematic of the HfB₂ static CVD.

Supplementary Figure S8 – AES depth profile of HfB₂ deposited by static CVD. Silicon was used as the substrate.
Supplementary Figure S9 – XRD pattern of a HfB₂ coated colloidal crystal. This data was collected after annealing at 1,000 °C for 12 hours. As deposited, the HfB₂ material was amorphous.

Supplementary Figure S10 - HfB₂ coated colloidal crystal after annealing to 1,000 °C. The top-view SEM micrograph shows large scale cracking, likely due to material densification, after annealing at 1,000 °C for 12 hours. Scale bar, 10 µm.