

## Wafer-Scale MgB<sub>2</sub> Superconducting Devices

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X-ray photoelectron spectroscopy (XPS) depth profile of MgB<sub>2</sub> thin films used to create Figure 3c

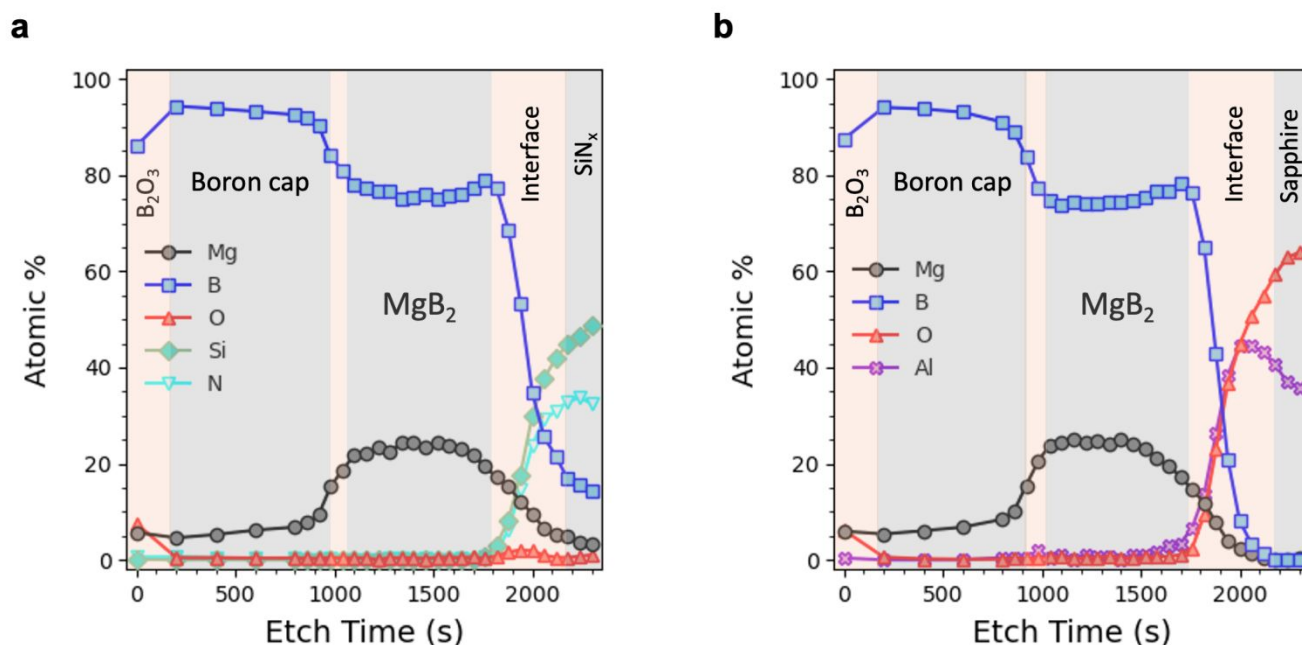


Figure S1 | Atomic percentages of different elements in MgB<sub>2</sub> film sample stack on (a) silicon nitride buffer on silicon, and (b) sapphire by depth profile XPS. Both samples have boron caps with surface oxide (B<sub>2</sub>O<sub>3</sub>) and few atomic % of Mg, indicating there is some diffusion of magnesium into the capping layer, likely forming MgB<sub>4</sub> or MgB<sub>7</sub>. The atomic % of Mg in MgB<sub>2</sub> layer is generally flat in (a) considering depth resolution of XPS, but clearly shows a decrease towards MgB<sub>2</sub>/sapphire interface in (b). In (a), there is some diffusion of boron from MgB<sub>2</sub> layer to silicon nitride layer, but no diffusion of silicon or nitrogen from the nitride layer to the MgB<sub>2</sub> layer. Etch times do not correspond directly to layer thicknesses, since etch rates are different for each layer, with MgB<sub>2</sub> being the highest, followed by boron, then sapphire and silicon nitride.

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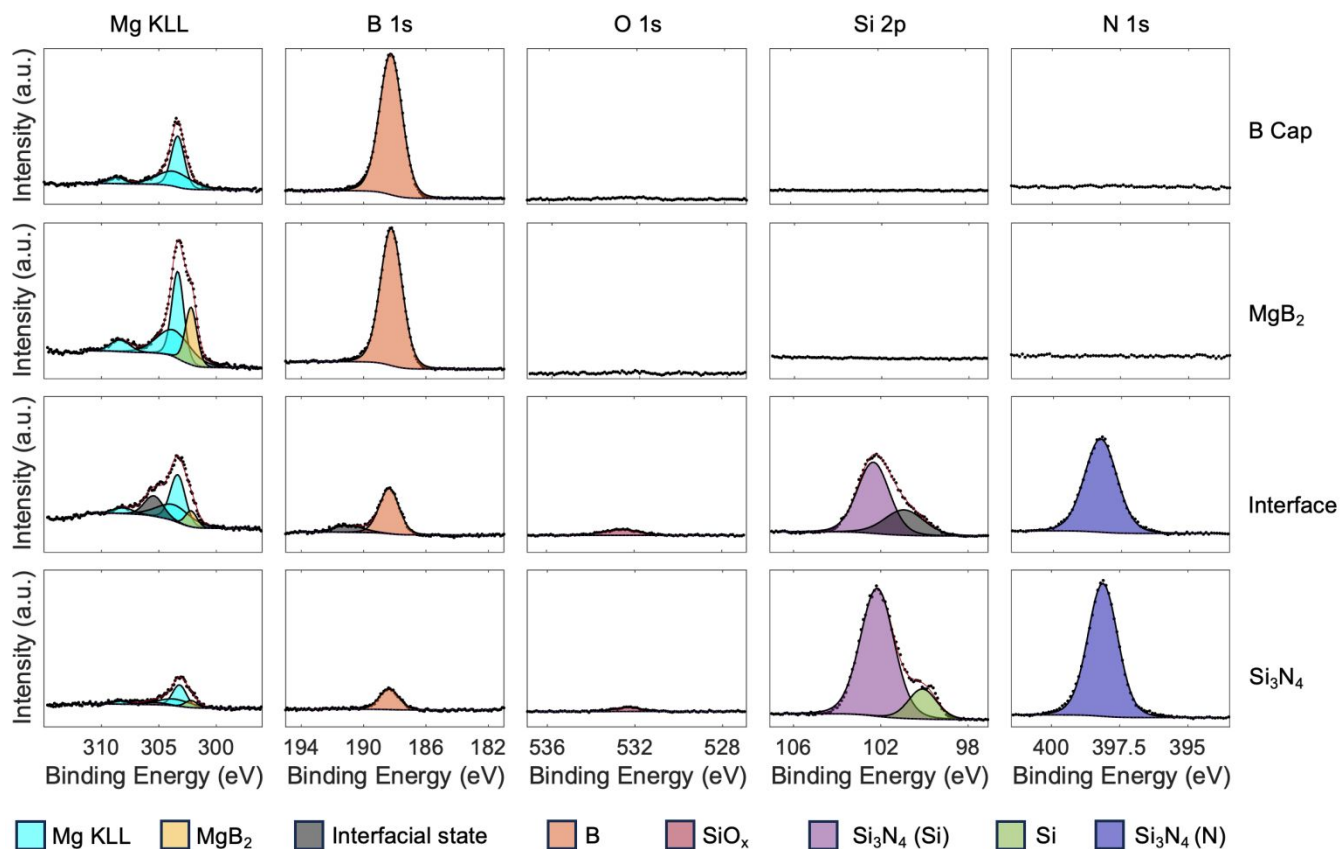
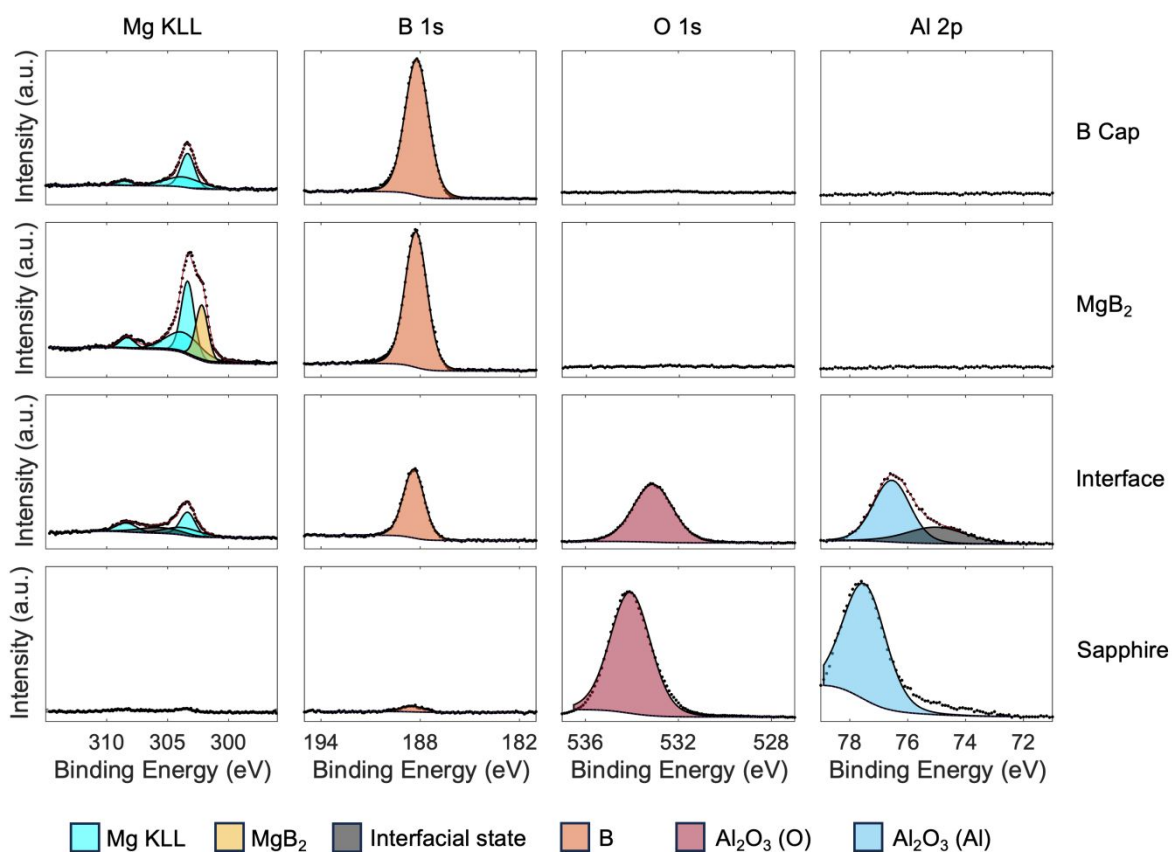


Figure S2 | Representative x-ray photoelectron (XP) spectra (columns) of Mg KLL, B 1s, O 1s, Si 2p and N 1s in each layer of MgB<sub>2</sub> sample stack on silicon nitride as denoted by row labels. Mg KLL transitions are not assigned here due to uncertainty in the composition and intensity of transitions in the observed chemistry. In the B cap layer, Mg KLL displayed 3 peaks, but likely originating from a Mg boride (MgB<sub>2</sub>, MgB<sub>4</sub> or MgB<sub>7</sub>) as no other elements were detected in this region. In the MgB<sub>2</sub> layer, an additional peak is found at a lower BE (higher KE, in Auger convention) which is likely from MgB<sub>2</sub>. At the MgB<sub>2</sub>/Si<sub>3</sub>N<sub>4</sub> interface, an additional Mg KLL peak is observed at ~306 eV BE along with a B 1s peak at ~191 eV and a Si 2p peak at ~101 eV as an O impurity is detected. Each of these observations is consistent with an oxide impurity, likely consisting of Mg, B, and Si, but not N. Once the interface is etched through, a small amount of Mg, B, and O is still detected, but the primary signals are Si<sub>3</sub>N<sub>4</sub> and underlying Si.



**Figure S3** | Representative XP spectra (columns) of Mg KLL, B 1s, O 1s, and Al 2p in each layer of MgB<sub>2</sub> sample stack on sapphire as denoted by row labels. Mg KLL transitions are not assigned due to uncertainty in the composition and intensity of transitions in the observed chemistry. In the B cap layer, Mg KLL displayed 3 peaks, but likely originating from a Mg boride as no other elements were detected in this region. In the MgB<sub>2</sub> layer, an additional peak is found at a lower BE (higher KE, in Auger convention) which is likely from MgB<sub>2</sub>. At the MgB<sub>2</sub>/sapphire interface, an additional Mg KLL peak is observed at ~306 eV BE and the peak at 308 eV is intensified, indicative of a Mg oxide. No corresponding peak is observed in the B spectra so the interfacial species is likely primarily composed of Mg, Al and O. Once the interface is etched through, the primary signal is of sapphire (Al<sub>2</sub>O<sub>3</sub>). There is uncompensated shift in O 1s and Al 2p peaks due to differential charging of the sapphire substrate and MgB<sub>2</sub> overlayer, so binding energy of these peaks is not diagnostic of chemical states.