Supplementary Information: Ferroelectricity at 900 °C in a 1 Unit-Cell-Thick Film

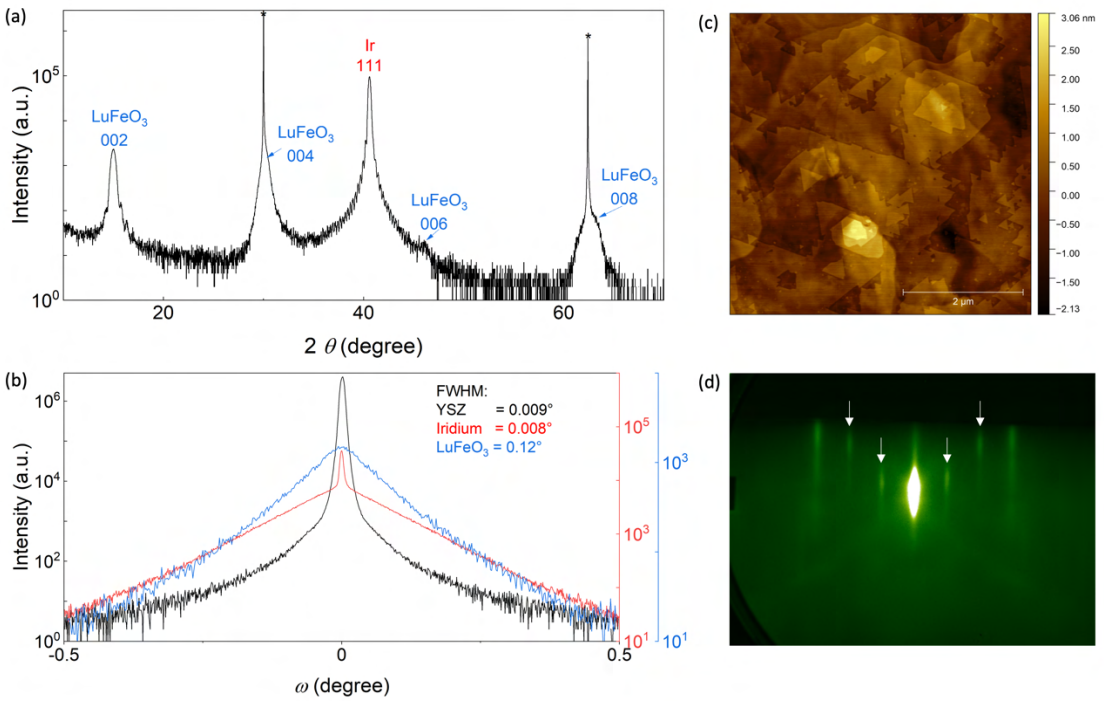

Figure S1 | X-ray diffraction, AFM, and RHEED of a *h*-$LuFeO_3$/Ir/YSZ (111) epitaxial stack, where the thickness of the *h*-$LuFeO_3$ layer is ~17.5 nm (15-unit cells). (a) A θ-2θ scan. (b) Overlaid ω rocking curves, specifically the 111 YSZ, 111 Ir, and 002 *h*-$LuFeO_3$ peaks. (c) AFM of the *h*-$LuFeO_3$ layer. (d) RHEED image at the end of growth of the *h*-$LuFeO_3$ layer, taken at 1000 °C (thermocouple temperature, true substrate temperature is ~100 °C lower).

The θ-2θ scan (Fig. S1(a)) shows the expected peaks from (111) Ir and (001) *h*-$LuFeO_3$ with no detectable impurity phases. The ω-rocking curves in Fig. S1(b) assess the structural perfection. The full width at half maximum (FWHM) of 111 Ir peak is 29 arc sec (0.008°) and of the 002 *h*-$LuFeO_3$ peak is 0.12°. Fig. S1(d) displays *in situ* reflection high-energy electron diffraction (RHEED) patterns. Extra streaks marked by white arrows result from the ferroelectric trimer distortions of *h*-$LuFeO_3$.

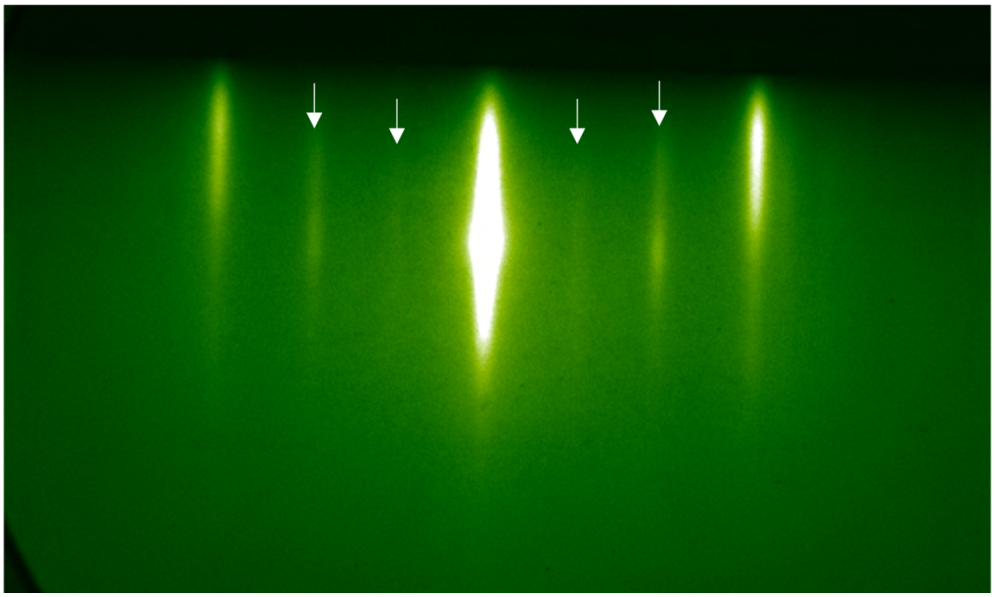

Figure S2 | *In-situ* RHEED patterns of a 1-unit-cell thick *h*-$LuFeO_3$/Ir/YSZ (111) sample at ~1000 °C (growth temperature measured by thermocouple, true substrate temperature is about 100 °C lower)

In Figure S2, clear 1/3-order streaks marked by white arrows indicate that *h*-$LuFeO_3$ films as thin as 1-unit cell are still ferroelectric at ~900 °C (true substrate temperature).