Electronic Supplementary Material (ESI) for Soft Matter.

Supporting Information for

Three-dimensional lattice deformation of blue phase liquid crystals under electrostriction

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Optical texture of the intermediate “quasi-tetragonal” phase

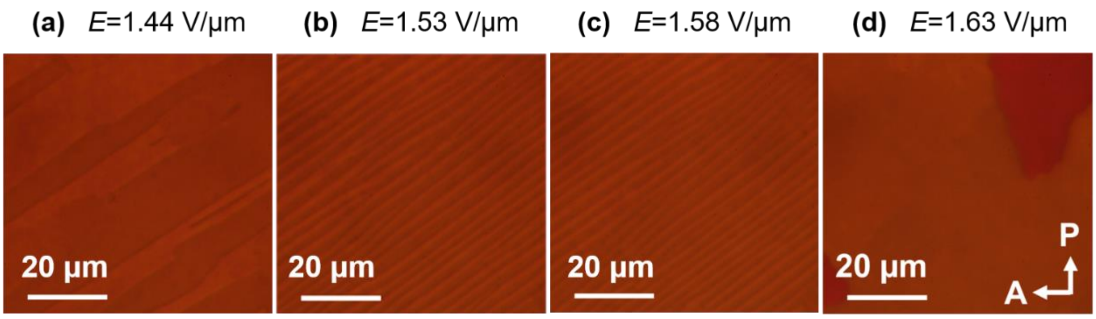


Fig. S1 POM images of the BP $I_{(110)}$ twinning sample, showing the phase transitions of orthorhombic (E=1.44 V/μm)→quasi-tetragonal (E=1.53~1.58 V/μm)→tetragonal (E=1.63 V/μm).

Discontinuous lattice elongation along the field

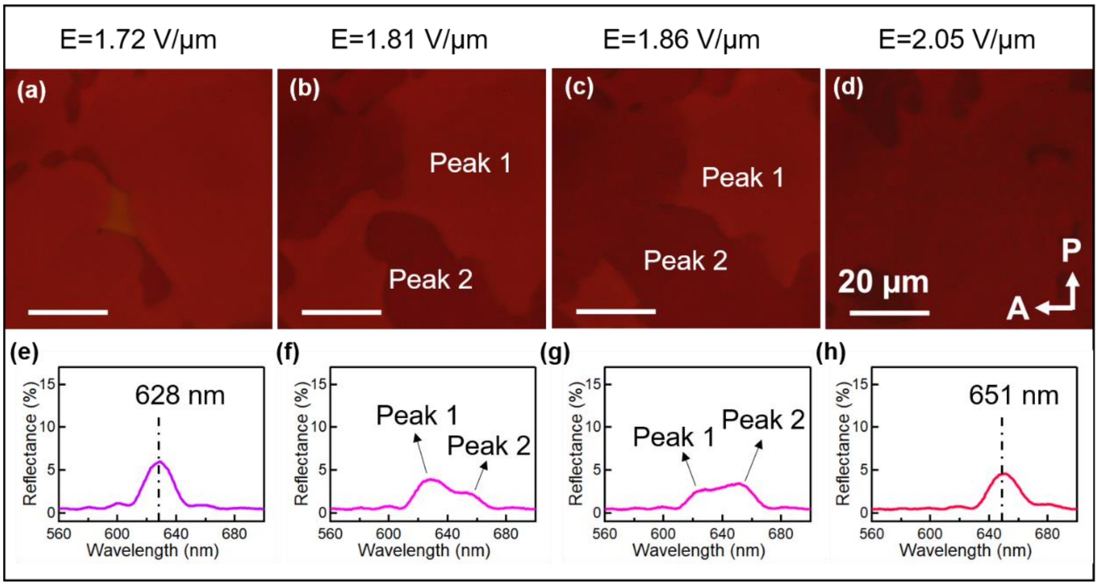


Fig. S2 POM images and reflection spectrum of BP I crystals at varied field intensities. The gradual transition of the POM texture and the discrete redshift of reflection peaks indicate the discontinuous elongation of BP I lattice along the field direction.

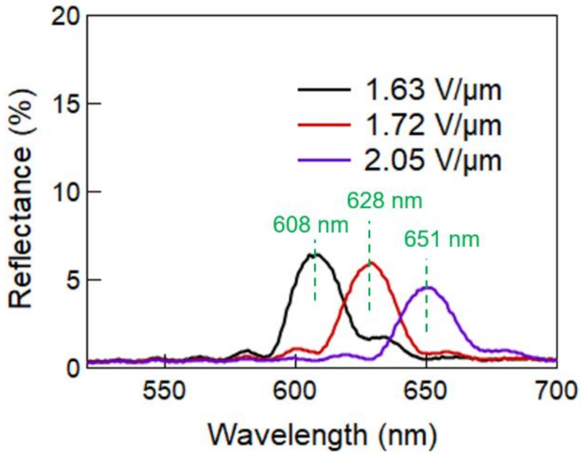


Fig. S3 Reflection spectrum of tetragonal BP I crystals respectively at E=1.63, 1.72 and 2.05 V/μm (Cell thickness: d=5.6 μm). The Bragg peak wavelength at each field intensity is obtained by fitting Gaussian function.

Spectra of BP I$_{(110)}$ crystals confined in a 14.9 μm-thick cell

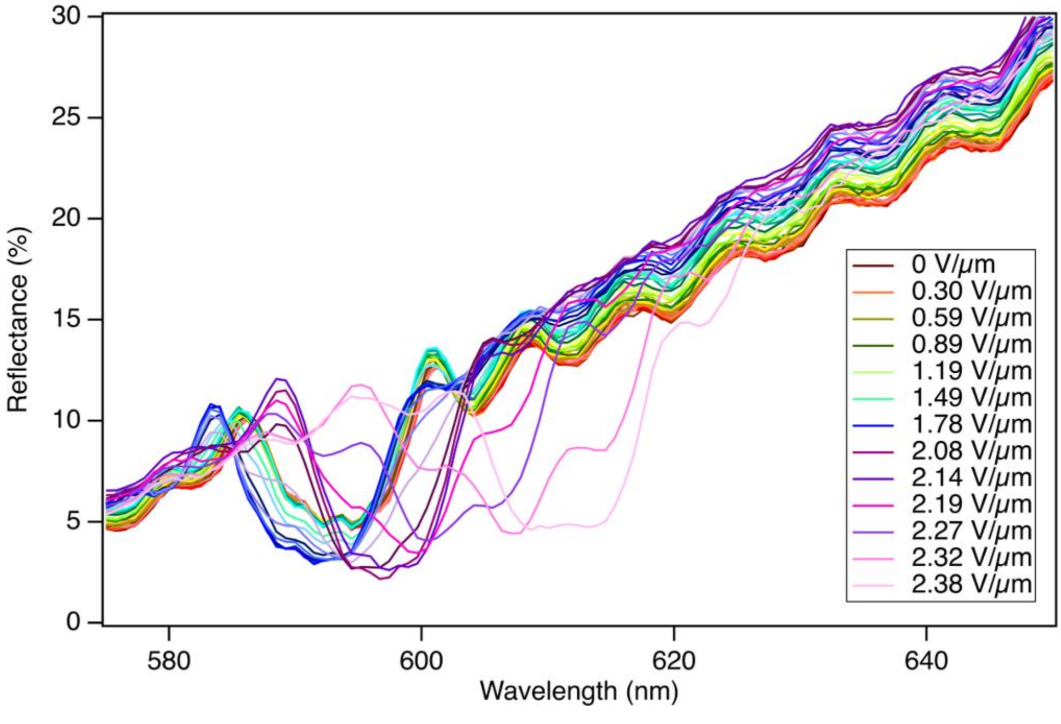
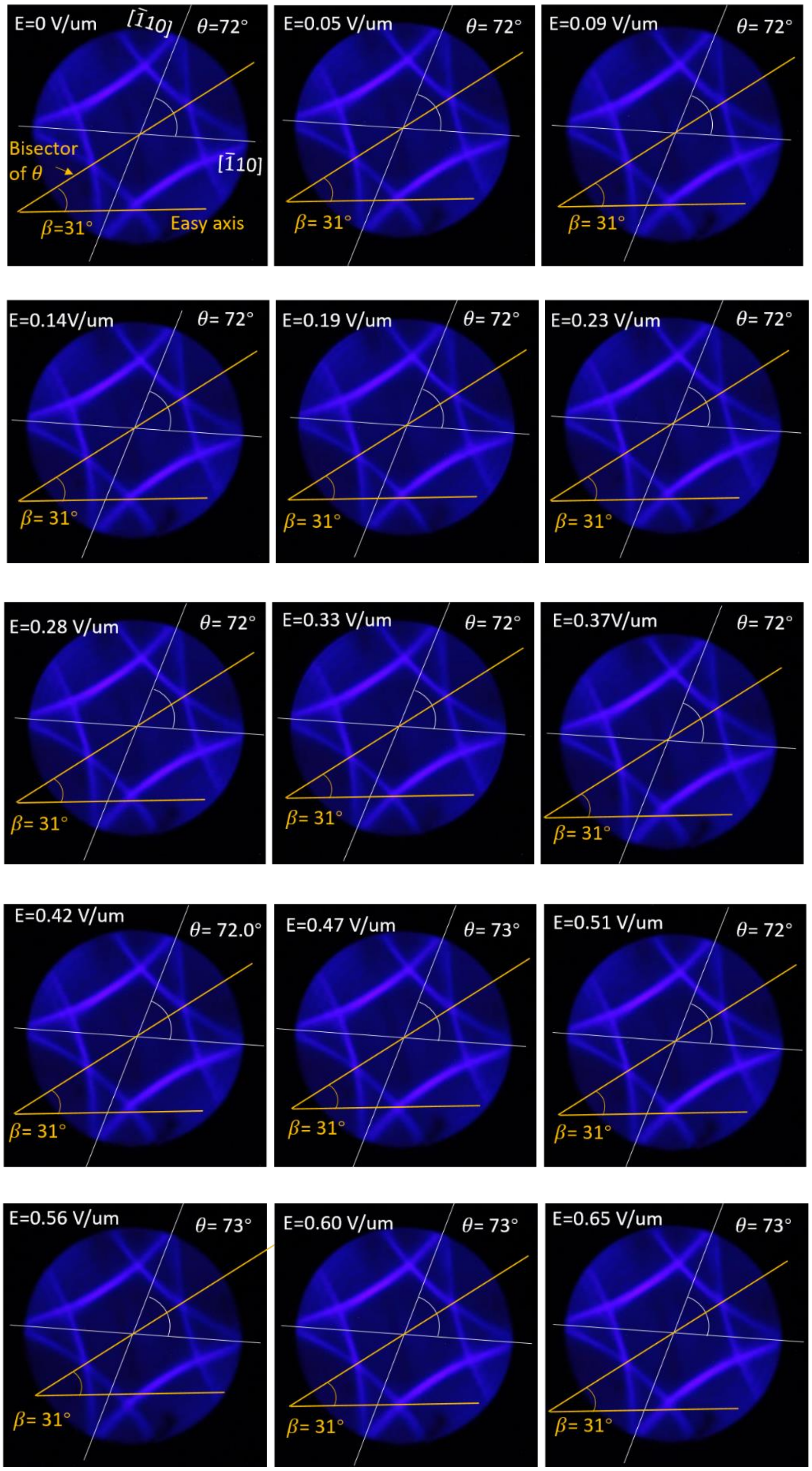
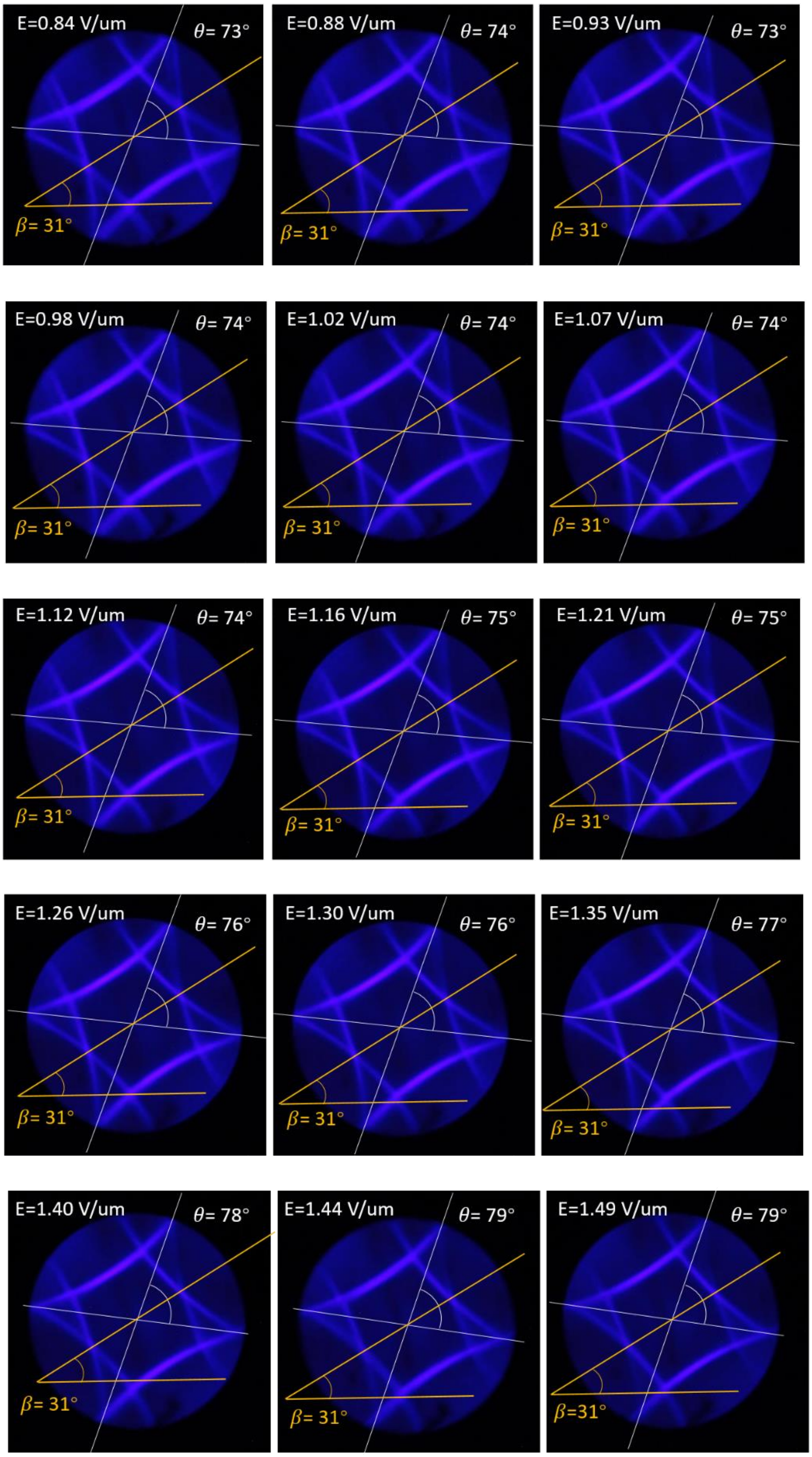


Fig. S4 Transmission spectra of the BP I$_{(110)}$ crystals confined in a 14.9 μm cell.

Raw Kossel pattern data under varying field intensities




E=0.84 V/um
θ= 73°
β= 31°
E=0.88 V/um
θ= 74°
β= 31°
E=0.93 V/um
θ= 73°
β= 31°
E=0.98 V/um
θ= 74°
β= 31°
E=1.02 V/um
θ= 74°
β= 31°
E=1.07 V/um
θ= 74°
β= 31°
E=1.12 V/um
θ= 74°
β= 31°
E=1.16 V/um
θ= 75°
β= 31°
E=1.21 V/um
θ= 75°
β= 31°
E=1.26 V/um
θ= 76°
β= 31°
E=1.30 V/um
θ= 76°
β= 31°
E=1.35 V/um
θ= 77°
β= 31°
E=1.40 V/um
θ= 78°
β= 31°
E=1.44 V/um
θ= 79°
β= 31°
E=1.49 V/um
θ= 79°
β=31°

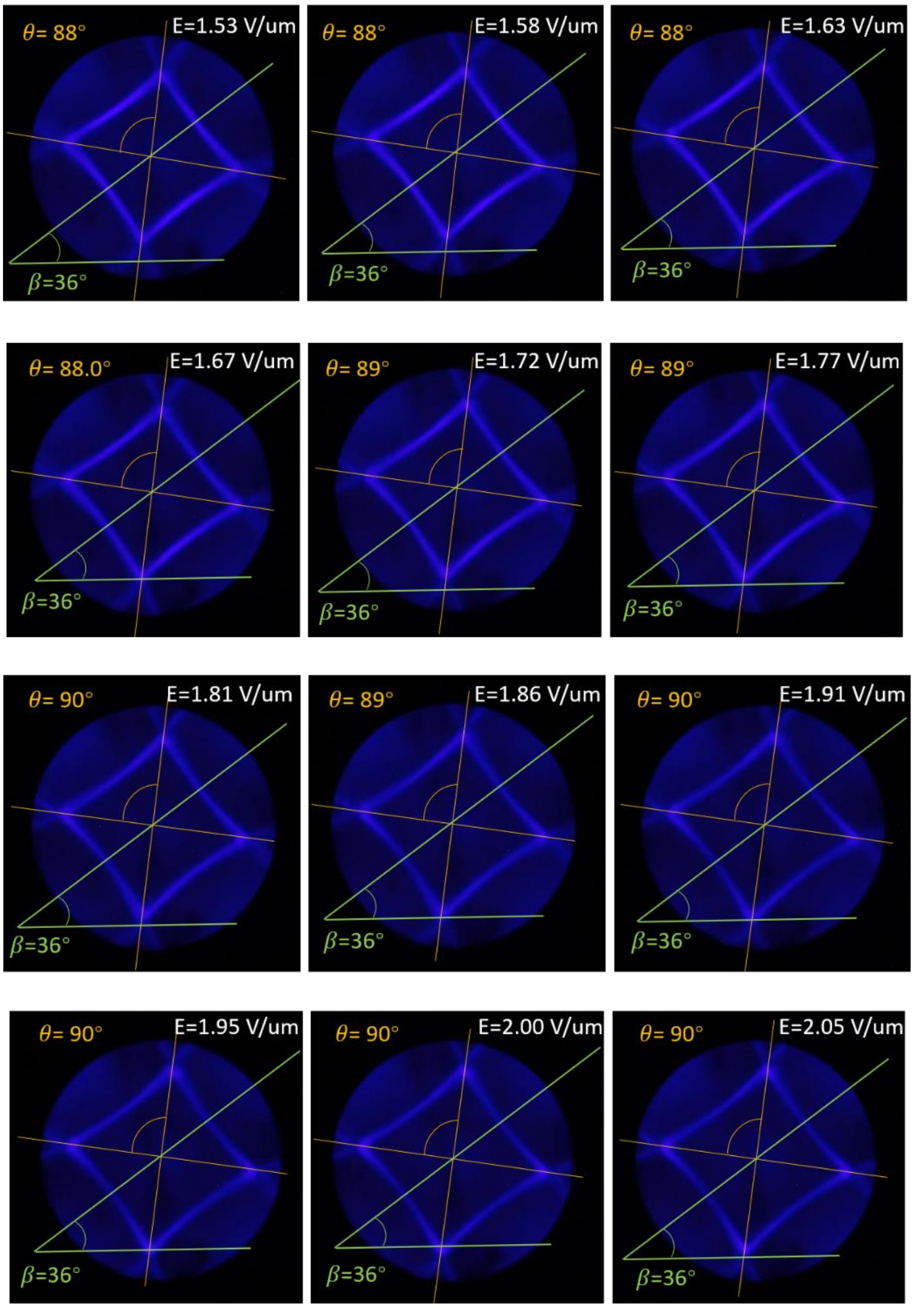


Fig. S5 Kossel diagrams of the BP $I_{(110)}$ twinned crystals under varied electric-field intensities, where the angle β indicates the lattice direction. The overlap angle θ is measured at each diagram to calculate *a and b*, the lattice constants perpendicular to the field.

Accuracy calculation of the lattice constant measurement

In this work, we use Equations (2)-(4) to calculate the three-dimensional lattice constants:

$$\begin{cases} c = \lambda / n & (2) \\ b = \sqrt{\dfrac{V_0}{c\tan(\theta/2)}} & (3) \\ a = b\tan(\theta/2) & (4) \end{cases}$$

The main error comes from the overlap angle (θ) measurement that affect the accuracy of a and b in the field-perpendicular direction, and the field-induced variation of refractive index (n) of BPs that affect the accuracy of c along the field direction.

(1) The overlap angles in Kossel diagram are measured by the screen protractor as follows in Figure S5, with the accuracy of 1’ for each $[\bar{1}10]$ axis. Considering the $[\bar{1}10]$ axes are manually drawn, we set the error to ±0.5° for the $[\bar{1}10]$ axis and thus, the accuracy of measurement overlap angle θ is within ±1°.

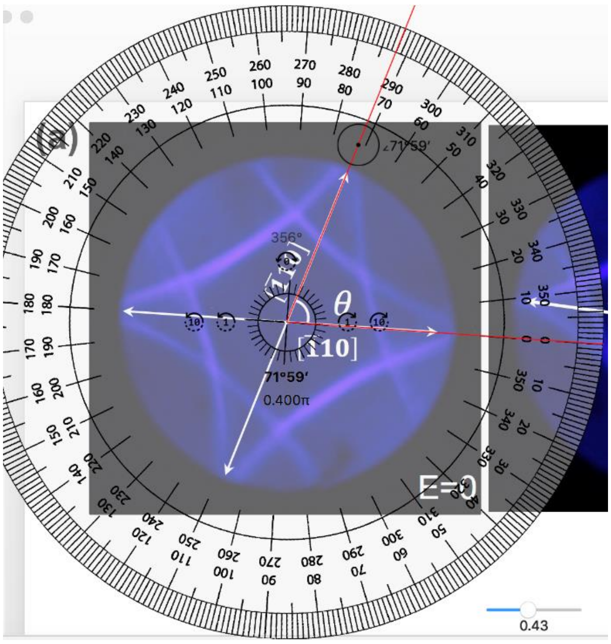


Fig. S6 Measuring the overlap angle θ in a Kossel diagram.

During the electrostriction, θ is measured as 72° to 90° and $V_E = V_0 = c_0^{\,3}\tan(\theta_0/2)$.

For θ=72° at E=0, the estimated values perpendicular to the field are a=282 nm, b=386 nm.

If we use θ=71°, the values turn to be a=275 nm, b=386 nm. **(Δmax = -7 nm)**

If we use θ=73°, the values turn to be a=286 nm, b=386 nm. (Δmax = 4 nm)

For θ=89.5° at E=2.05 V/μm, the estimated values are a=318 nm, b=321 nm.

If we use θ=88.5°, the values turn to be a=315 nm, b=323 nm. (Δmax= -3 nm)

If we use θ=90.5°, the values turn to be a=320 nm, b=317 nm. (Δmax= -4 nm)

For θ=79° at E=1.44 V/μm, the estimated values are a=301 nm, b=362 nm.

If we use θ=78°, the values turn to be a=296 nm, b=366 nm. (Δmax = -5 nm)

If we use θ=80°, the values turn to be a=301 nm, b=359 nm. (Δmax= 3 nm)

Because c is calculated from Bragg peak wavelength, the error comes from the angle measurement is within $\pm$7 nm.

(2) For the refractive index, since the field variation is less than 0.01 and n=1.58 was used in the main text, here we use n=1.59 and n=1.57 for $c=\lambda/n$:

At E=0, λ=610 nm, n=1.58 and c=386 nm;

if n=1.59, c=384 nm

if n=1.57, c=389 nm

(Δmax= 3 nm)

At E=1.72 V/μm, λ=628 nm, n=1.58 and c=397 nm;

if n=1.59, c=395 nm

if n=1.57, c=400 nm

(Δmax= 3 nm)

At E=2.05 V/μm, λ=651 nm, n=1.58 and c=412 nm;

if n=1.59, c=409 nm

if n=1.57, c=415 nm

(Δmax= 3 nm)

When we calculate a and b, we use the value of c directly, so the error caused by refractive index is within $\pm$3 nm.

To sum up, the accuracy for the lattice constant measurement is at least within ±10 nm.