Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

Supporting Information

Structure and magnetic properties of highly oriented $LaBaCo_2O_{5+\delta}$ films deposited on Si wafers with Pt/Ti buffer layer

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X-ray diffraction (XRD) pattern of the target is presented in Fig. S1, in which the sharp diffraction peaks demonstrate that the LBCO target is highly crystallized with a single phase. The result also reveals the possibility of realizing cationic disordered phase, which can be confirmed from the single peak of (200) LBCO (inset of Fig. S1).

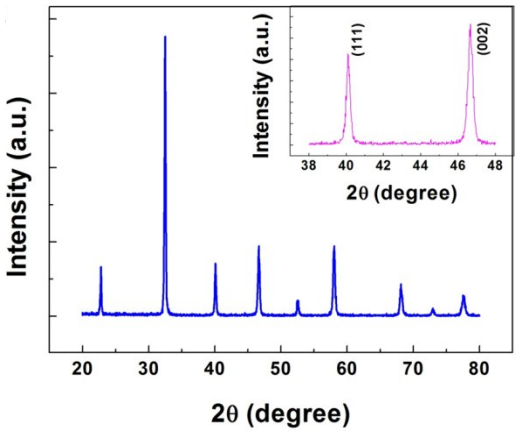

Figure S1. XRD pattern of $LaBaCo_2O_{5+\delta}$ (LBCO) target. The inset shows the zoom-in of the area with the (002) peak.

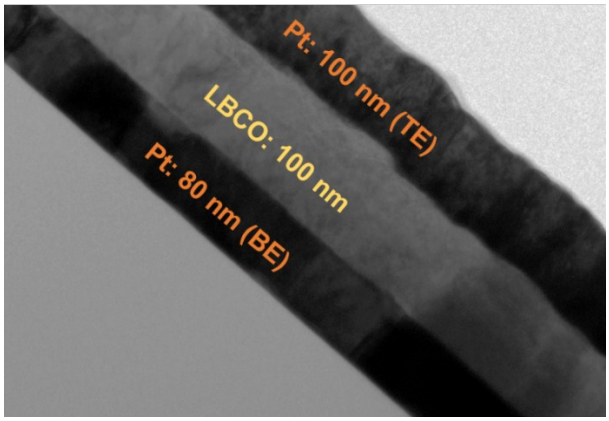

Figure S2. TEM image of the cross-section of the LBCO thin film sample. 100 nm-thick LBCO film is successfully integrated with 80 nm-thick Pt bottom electrode and 100 nm-thick Pt top contact.

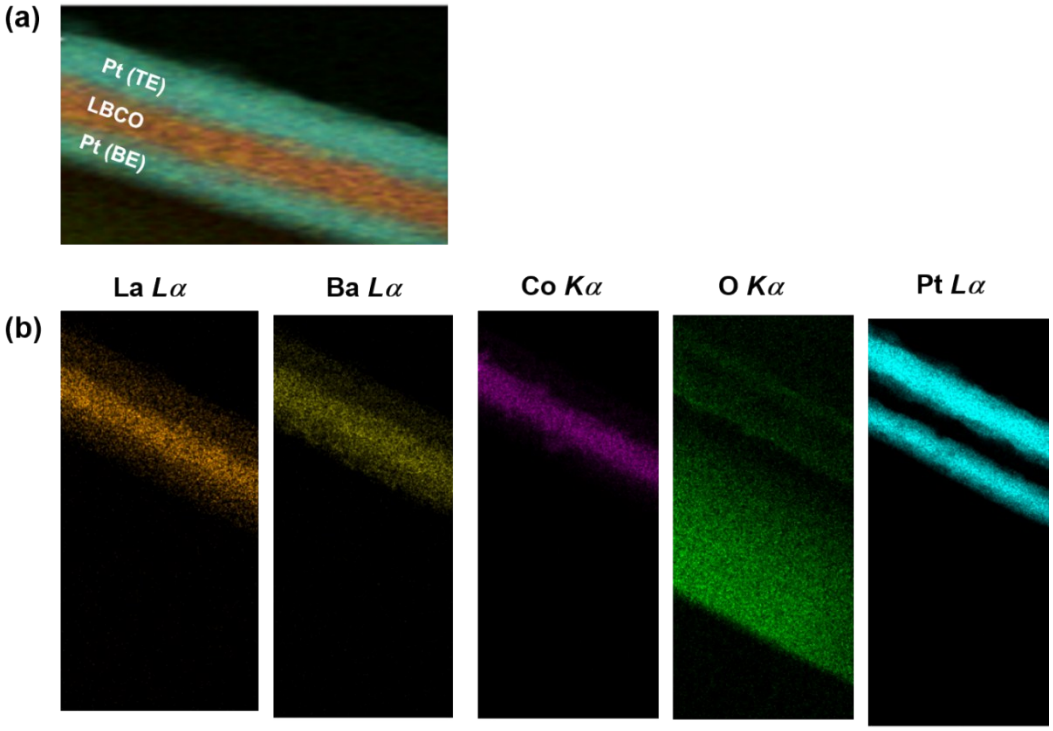

Figure S3. EDS elemental mapping of the LBCO film.

Calculation of crystallite size, lattice constant and microstrain:

The crystallize size and microstraian can be determined by the following equations:[1-3]

$$D_{hkl} = K\lambda / B_{1/2}\cos\theta ,$$

$$\varepsilon = B_{1/2}/4\tan\Theta ,$$

where D_{hkl} is the crystalline size along the direction perpendicular to the film surface, K = 0.94 is the Scherrer constant, $B_{1/2}$ is the full width at half maximum (FWHM), and λ = 0.15418 nm is the wavelength of $K\alpha$ radiation of Cu. The results is presented in Table SI below.

Table SI. Crystallite sizes (D_{hkl}), lattice parameters (C) and microstrain of LBCO films

Sample	Theta (deg)	FWHM (deg)	D_{hkl} (nm)	C (nm)	Strain (%)
As grown	22.93	0.50	16.9	0.395	1.64
Annealed	23.12	0.38	22.3	0.390	0.36
Control	23.36	0.26	37.2	0.389	0.10

Calculation of the compostion ratio using XPS analysis:

Using standard peaks (from the reference book for fitting Co 2p),[4] the peak position of both as-prepared and annealed samples are deduced from the Gaussian-Lorentz calculation, and summarized in Table SII.

Table SII. Binding energy of Co 2p obtained from Figure 3 (herein MP, SP and FWHM refer to the main peak, satellite peak and full width at half maximum, respectively)

Samples	Spin-orbit	Species	Binding Energy (eV)	Area	FWHM (eV)	Atomic conc. of oxygen (%)
Annealed	$2p_{3/2}$(MP)	Co^{3+}	778.12	1437.20	1.42	35.42
		Co^{4+}	780.25	6471.56	1.94	
	$2p_{1/2}$(MP)	Co^{3+}	793.38	795.63	1.32	
		Co^{4+}	795.6	4070.41	1.93	
As-prepared	$2p_{3/2}$(MP)	Co^{3+}	777.95	1472.43	0.999	34.79
		Co^{4+}	780.19	14211.22	2.15	
	$2p_{3/2}$(SP)	Co^{2+}	789.4	5354.68	2.98	
	$2p_{1/2}$(MP)	Co^{3+}	793.2	1097.73	0.84	
		Co^{4+}	795.47	8886.36	2.18	
	$2p_{1/2}$(SP)	Co^{2+}	803.56	3132.74	5.13	

We deduce that the average ratio is 1:6 and 1:9 for the as-grown and annealed LBCO films, respectively, which is akin to the higher oxygen content in the annealed sample.

References

1. K. Mallick and P. S. A. Kumar, *Journal of Applied Physics*, 2018, **124**, 053901.
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3. A. Goktas, A. Tumbul and F. Aslan, *Journal of Sol-Gel Science and Technology*, 2016, **78**, 262-269.
4. J. F. Moulder, *Physical electronics*, 1995, 230-232.