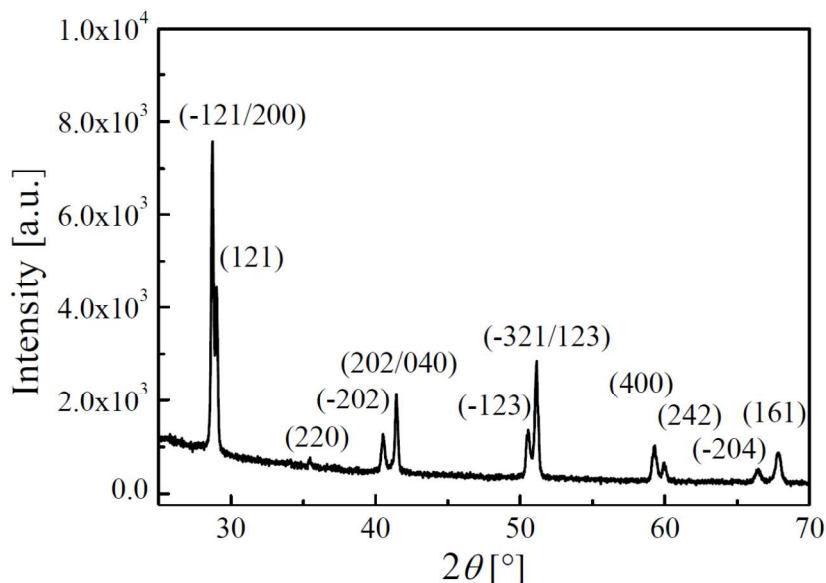


1 Supporting Information



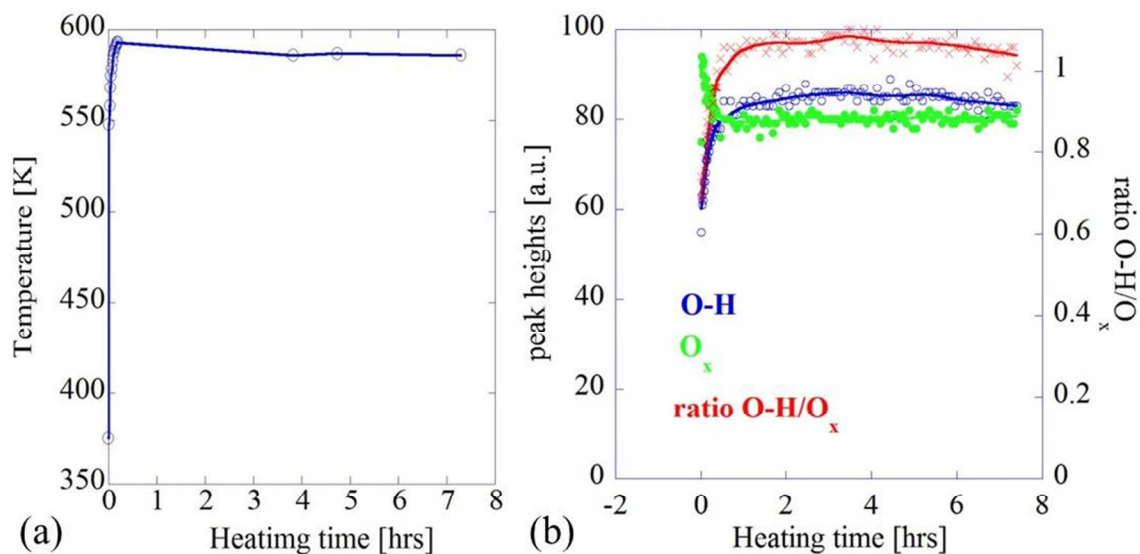
2

3 **Figure S1:** X-ray diffractogram of powder from the BCY20 pellet recorded with Cu K- α
4 radiation, confirming phase purity.

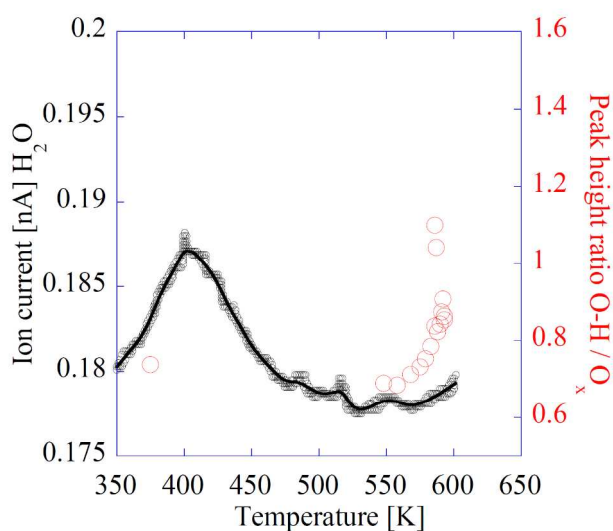
5 We have monitored the evolution of the spectral weight at 593 K of either peak in UHV
6 condition in excess of 7 hours, collecting a total of 485 spectra. The heating profile is
7 shown in Figure S2 a. The transient of the relative peak heights of O_x and O-H and their
8 ratio $O-H/O_x$ is displayed in Figure S2 b. The spectral weight of the hydroxyl groups is
9 rapidly increasing, and the spectral weight of the structural oxygen is decreasing to the
10 same extent. Overall, the ratio of the spectral weights increases sharply within 1 hour of
11 keeping the temperature around 593 K, and then remains virtually constant for the
12 following 6 hours.

13 We believe thus that the O-H groups are formed during annealing on the sample surface
14 from residual water from exposure to ambient conditions, thus causing a relative decrease
15 of the spectral weight from O_x . Comparison with thermogravimetry data (Figure S3 a,

16 adopted from $\text{BaCe}_{0.85}\text{Yb}_{0.15}\text{O}_3$ in Ref. [11]) shows that surface water is released at 373 K
 17 and structural water at 593 K, suggesting that structural oxygen O_x in BCY20 indeed
 18 could be released from the sample at 593 K in UHV.



19
 20 **Figure S2:** Heating profile (left) and evolution of spectral weight (right) of the O1s core
 21 level XPS peaks for O-H, O_x , and their ratio O-H/ O_x .



22
 23 **Figure S3:** Ion current from water release (solid line from 350 K to 600 K) and XPS peak
 24 height ratio for O-H/ O_x .