Supplementary Material

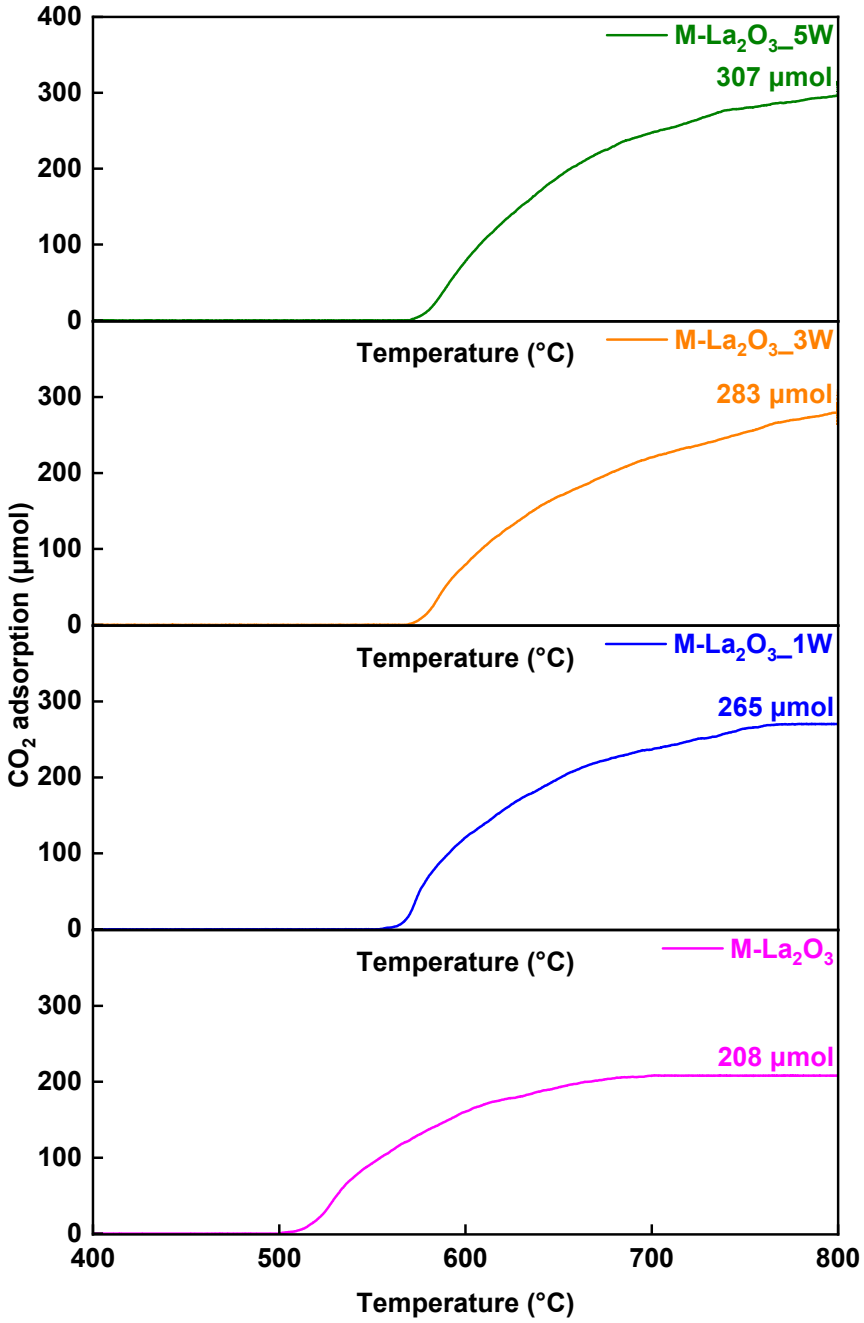

Figure S1. The process of total CO_2 adsorption of four samples in Figure 3 as a function of temperature.

In the main text, the data shown in Figure 3 is highly discrete, especially the conversion of CH_4 and yield of C_2 on M-La_2O_3_3W. Thus, the fitting curves of the discrete data is added to the Figure, and it is

inevitable that there has errors between discrete data and the fitting curves. Figure S2 exhibits all the errors between discrete data and the fitting curves, standard deviation line and mean absolute deviation (MAD). Some calculated detailed are shown as below:

The standard deviation is estimated by:

$$\sigma = \pm\sqrt{\frac{\sum_{i=1}^{n}(x_i-\mu)^2}{n}} \quad (1)$$

The mean absolute deviation is estimated by:

$$\mathrm{MAD} = \frac{1}{n}\sum_{i=1}^{n}|x_i-\mu| \quad (2)$$

Where σ is the standard deviation, it is shown as two lines in Figure S2.

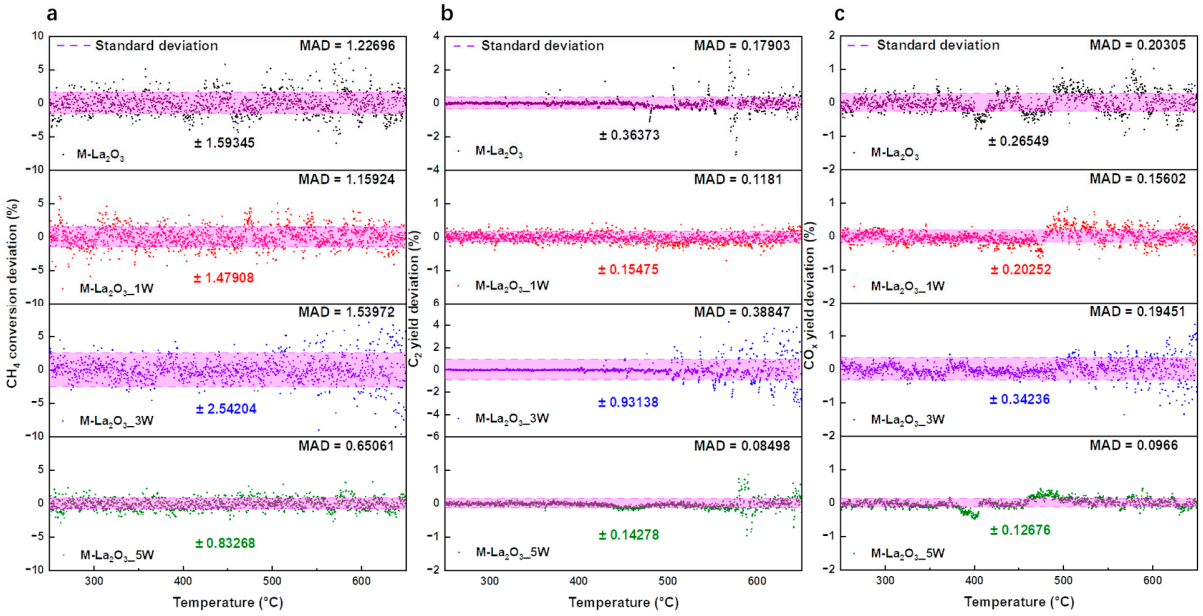

Figure S2 Plots of the standard deviation and mean absolute deviation between the a) CH_4 conversion, b) C_2 yield and c) CO_x yield discrete data and the fitting curves in Fig 4. The purple area is the standard deviation range for each set of data.

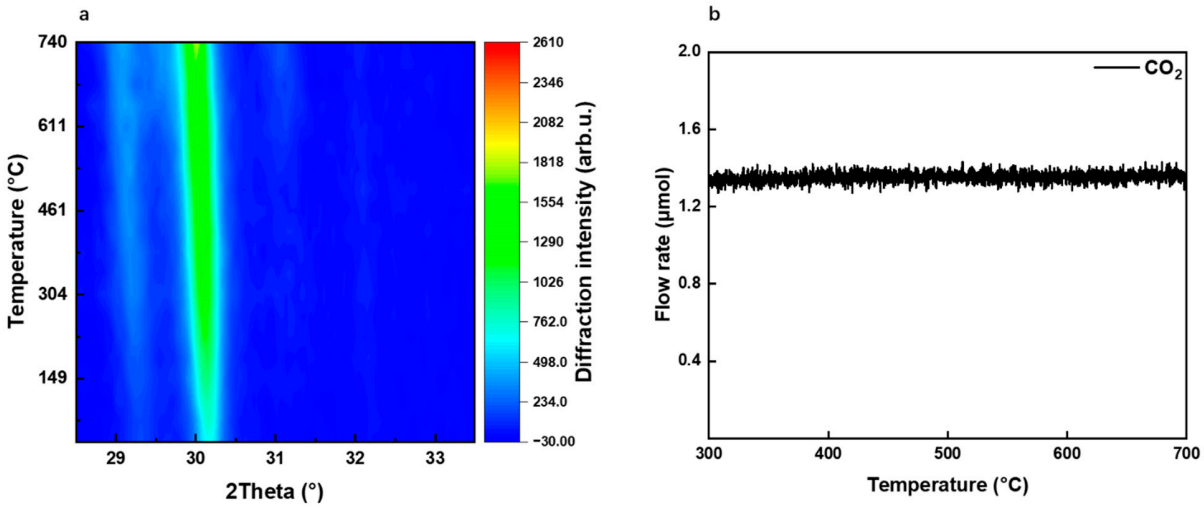

Figure S3 a) *In situ* XRD and b) online MS result of CO_2 uptake on M-La_2O_3_5W with 10% CO_2-Ar (20 sccm), sample loading is 0.10 g.

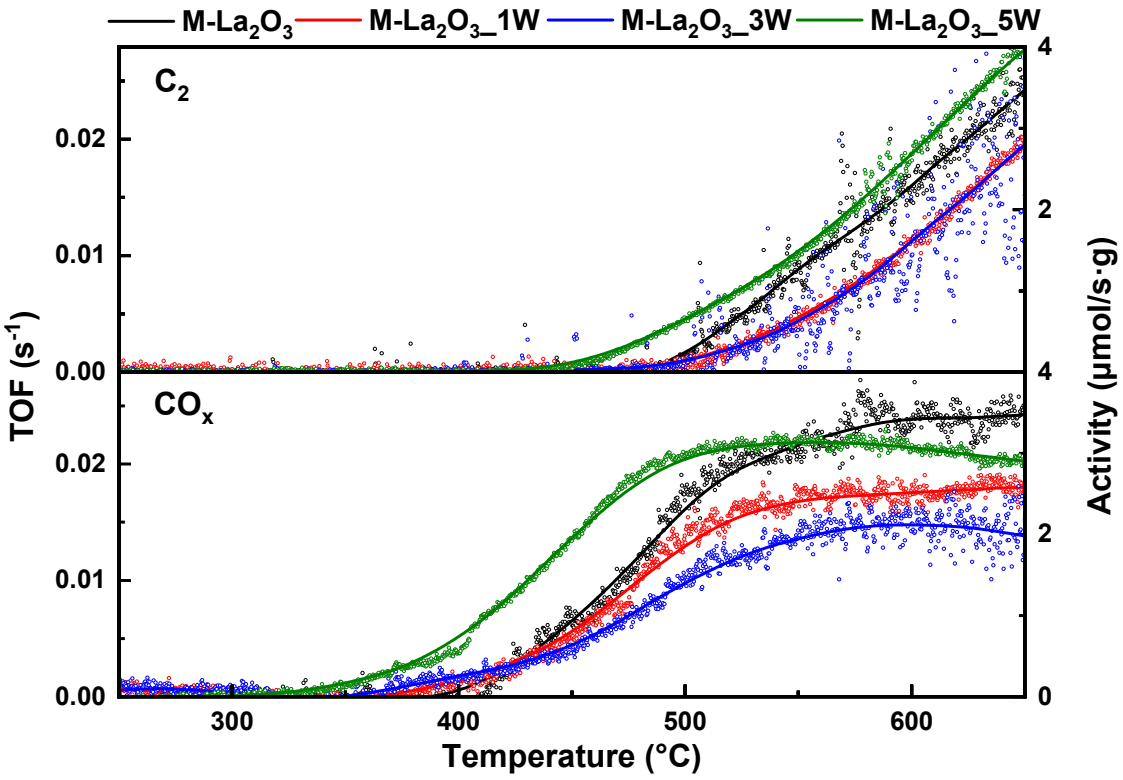

Figure S4 The C_2, CO_x activity and TOF calculated from Figure 4.