**Electronic Supplementary Material (ESI) for Nanoscale.**

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Supplementary information

# Simultaneously adsorption, activation and in-situ reduction of carbon dioxide over Au loading BiOCl with rich oxygen vacancies

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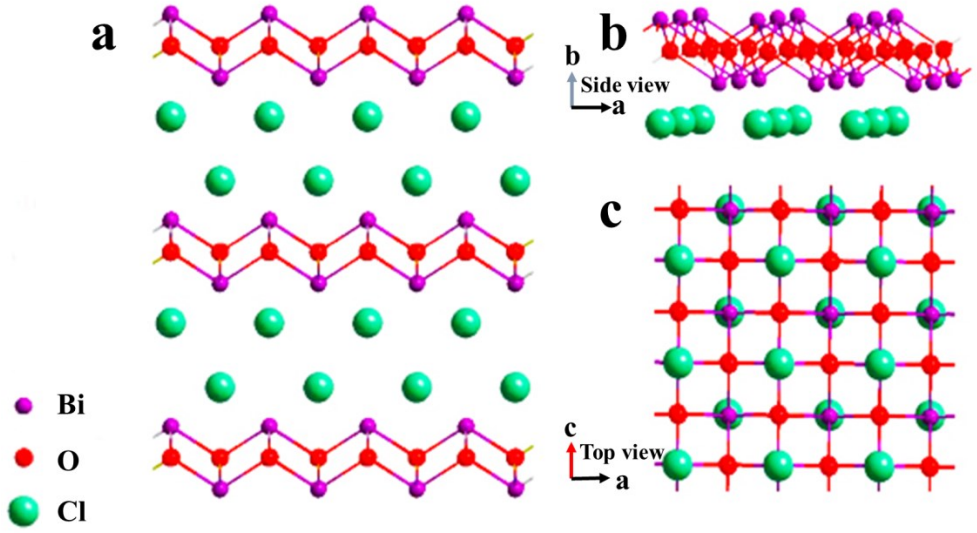


**Scheme S1.** Schematic illustrations of BiOCl crystals simulated by VESTA.

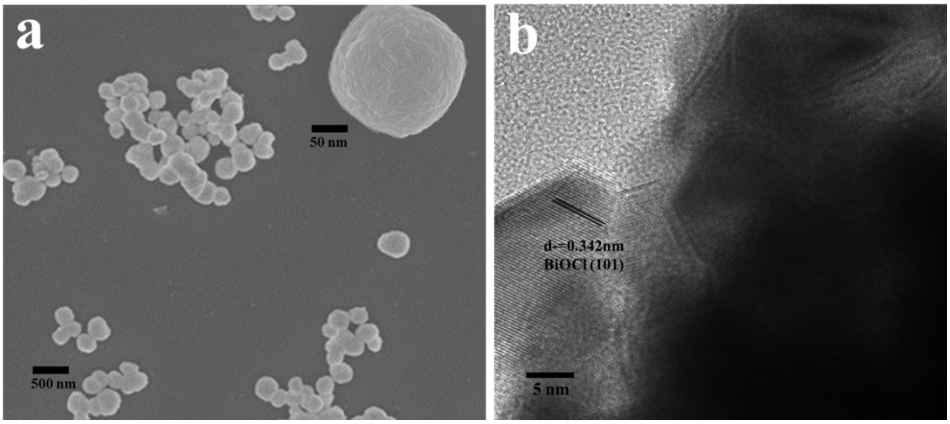


**Fig. S1.** (a) SEM images, (b) HRTEM image of BiOCl-OV.

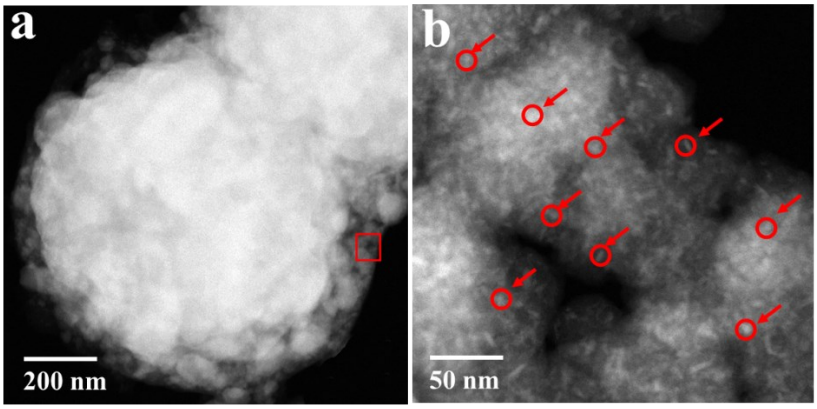


**Fig. S2.** HADDF-STEM images of 0.25% Au-BiOCl-OV.

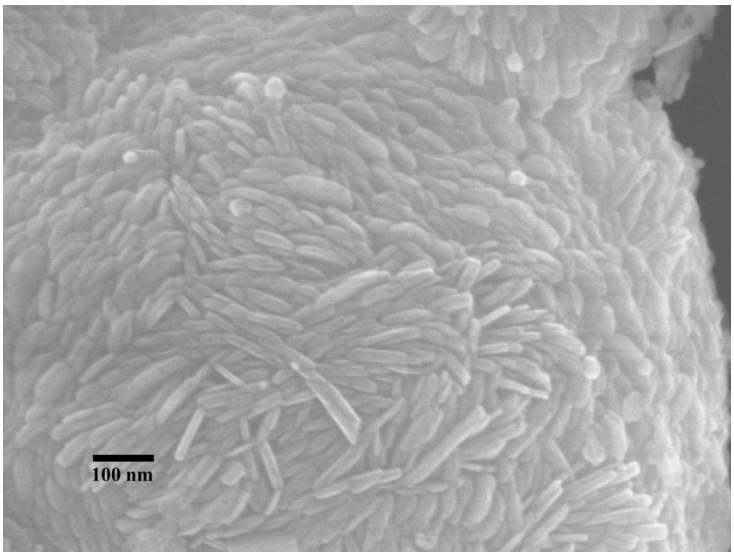

**Fig. S3.** SEM images of C-Au-BiOCl-OV.

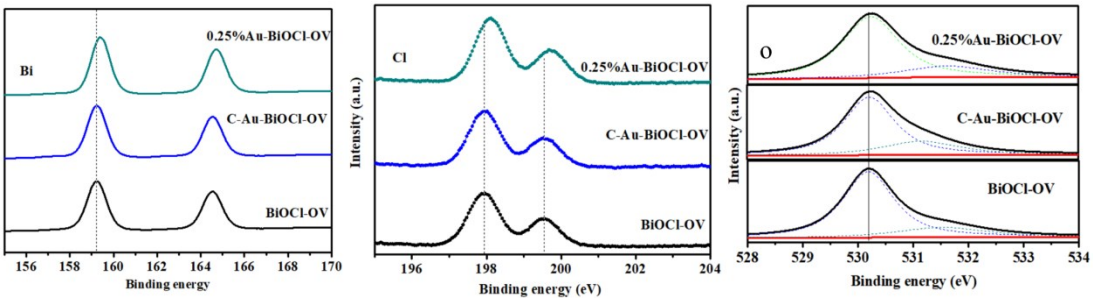


**Fig. S4.** XPS survey spectra of BiOCl-OV, 0.25% Au-BiOCl-OV and C-Au-BiOCl-OV.

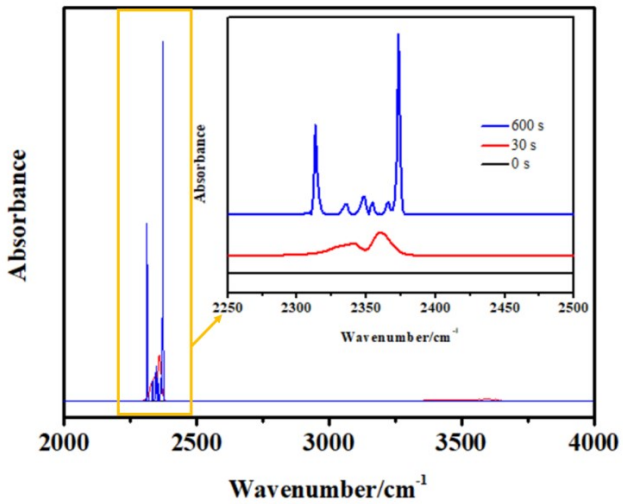


**Fig. S5.** In-situ FTIR spectra of Au-BiOCl-OV over $CO_2$ + $H_2O$ in the dark for 0, 30, 300 s.

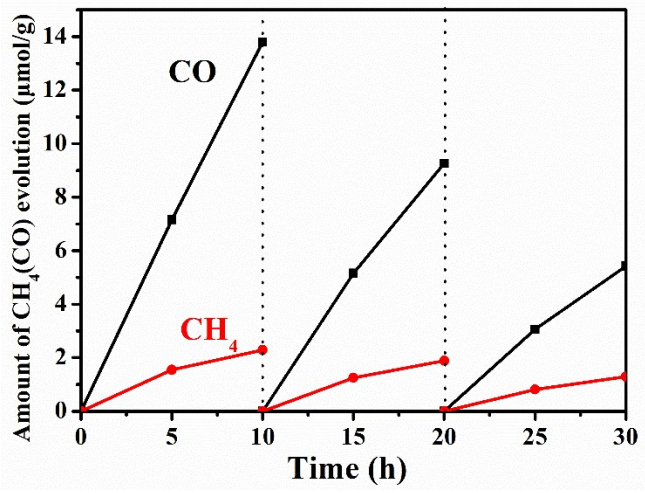


**Fig. S6.** The recyclability test of the C-Au-BiOCl-OV photocatalyst under light irradiation.

Table S1. Comparison of the photocatalytic $CO_2$ reduction rates of BiOX-based photocatalysts without sacrificial agent.

| Photocatalysts | Light source | CO (μmolh$^{-1}$g$^{-1}$) | $CH_4$ (μmolh$^{-1}$g$^{-1}$) | Ref. |
|---|---|---|---|---|
| BiOI | 300W Xe lamp | 0.70 | 0.27 | [1] |
| BiOCl | 500W Xe lamp | 1.01 | 0.15 | [2] |
| BiOBr | 300W Xe lamp | 1.68 | 0.16 | [3] |
| $Bi_4O_5Br_2$ | 300W Xe lamp | 2.74 | 2.04 | [3] |
| BiOI | 300W Xe lamp | 0.51 | 0.18 | [3] |
| Bi5O7I | 300 W Xe lamp | 1.73 | 0.18 | [4] |
| g-$C_3N_4$/BiOI | 300 W Xe lamp | 4.86 | 0.18 | [5] |
| g-$C_3N_4$/BiOI/RGO | 300 W Xe lamp | 2.731 | / | [6] |
| g-C3N4/BiOBr | 300 W Xe lamp | 2.49 | 0.47 | [7] |
| ultrathin BiOBr | 300 W Xe | 2.67 | 0.16 | [8] |

| | | | | |
|---|---|---|---|---|
| | lamp | | | |
| Bi2O4/BiOBr | 300 W Xe lamp | 2.60 | 1.85 | [9] |
| g-C3N4/BiOI | 300 W Xe lamp | 3.45 | 0.16 | [10] |
| 0.25% Au/ BiOCl-OV | 300 W Xe lamp | 3.46 | 1.39 | This work |

Table S2. Lifetime fitted from TRPL spectra of BiOCl-OV, C-Au- BiOCl-OV and 0.25% Au-BiOCl-OV.

| Samples | τ1 (ns) | A1 (%) | τ2 (ns) | A2 (%) | ⟨τ⟩ (ns) |
|---|---|---|---|---|---|
| BiOCl-OV | 0.43 | 42.17% | 1.43 | 57.83% | 1.01 |
| C-Au- BiOCl-OV | 0.59 | 61.83% | 2.87 | 38.17% | 1.46 |
| 0.25%Au- BiOCl-OV | 0.88 | 65.06% | 5.32 | 34.94% | 2.43 |

References


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