

# Synthesis, Characterization, Activity and Degraded Mechanisms of BiSeX and BiSeX/GO photocatalysts

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## Abstract

V–VI–VII compounds have been investigated in the last century because these compounds are candidates for optoelectronic applications. In particular, BiSeX (X = Cl, Br, I) is a group of V–VI–VII compounds with high dielectric constants, ferroelectric properties, excellent photoconductivity, and suitable valence bands. We successfully prepared a series of BiSeX by BiX<sub>3</sub> and selenium powder being dissolved in toluene with the simple hydrothermal method. The binary composite photocatalysts BiSeX/GO were mixed in different weight of GO in an autoclave and heated to 100 °C for 4 hours. The products were characterized by XRD, SEM-EDS, DR-UV, GC, BET, PL, UV-Vis-NIR and HR-XPS. The result showed that the photocatalytic conversion of CO<sub>2</sub> to hydrocarbons with 100% selectivity provided a method to produce chemical or energy products. It exhibited remarkable selectivity for multiple hydrocarbons. These time-varying concentrations of hydrocarbon profiles for photocatalytic reduction of CO<sub>2</sub> could provide strong evidence for speculating on the reaction mechanism. In alkaline solution, BiSeX/GO-mediated photocatalytic reduction of CO<sub>2</sub> underwent simultaneous deoxygenation and C-C coupling. To discuss BiSeX and BiSeX/GO for photocatalytic efficiency, the catalysts were used for CO<sub>2</sub> reduction and photocatalytic degradation of organic pollutants-crystal violet (CV) with significant effects, indicating that they were promising materials for reducing environmental pollution.

## Results and Discussion

### XRD

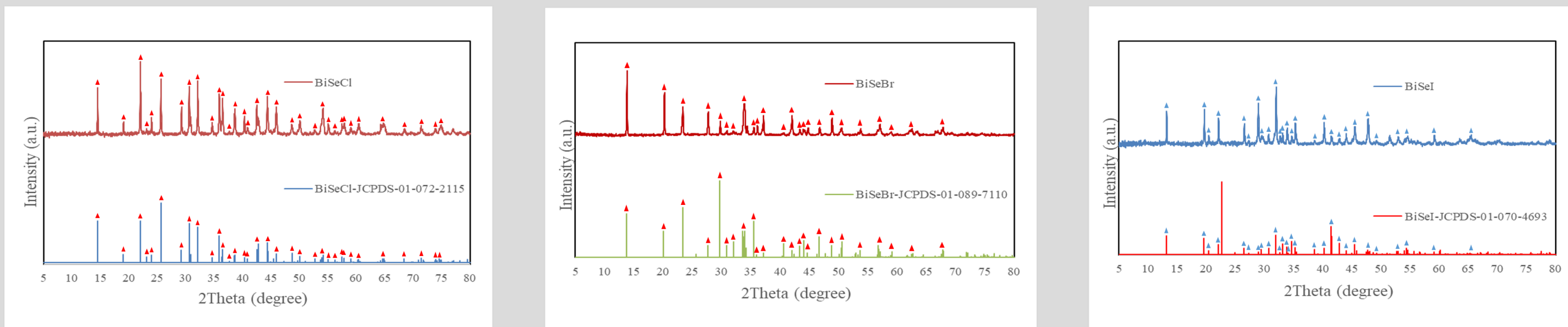


Fig.1 XRD patterns of BiSeX (X = Cl, Br, I).

### HR-XPS

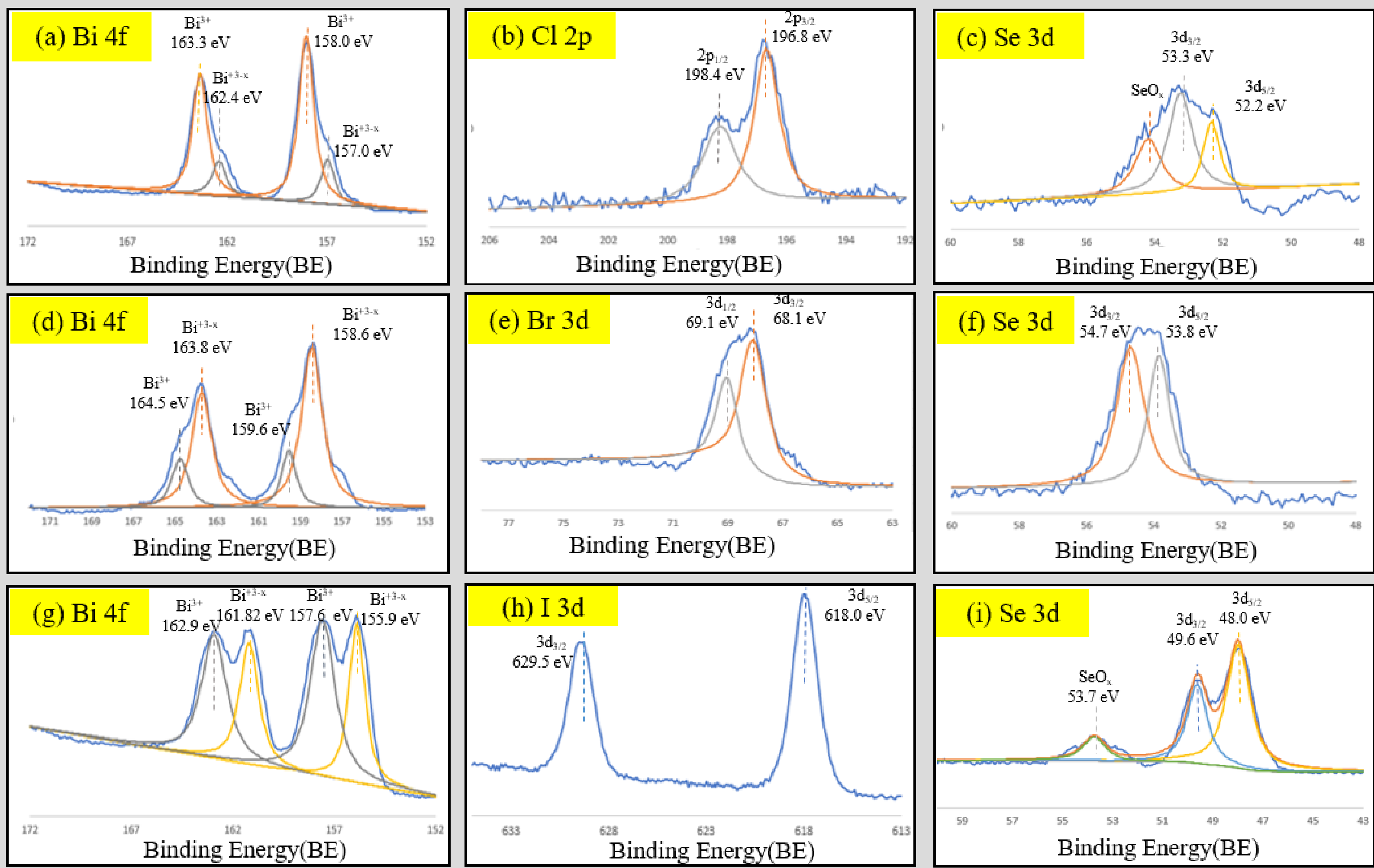


Fig 3. XPS spectra of the BiSeX samples: (a) Bi 4f, (b) Cl 2p, (c) Se 3d of the BiSeCl; (d) Bi 4f, (e) Br 3d, (f) Se 3d of the BiSeBr; (g) Bi 4f, (h) I 3d, (i) Se 3d of the BiSeI.

### Photocatalytic Degradation of CV

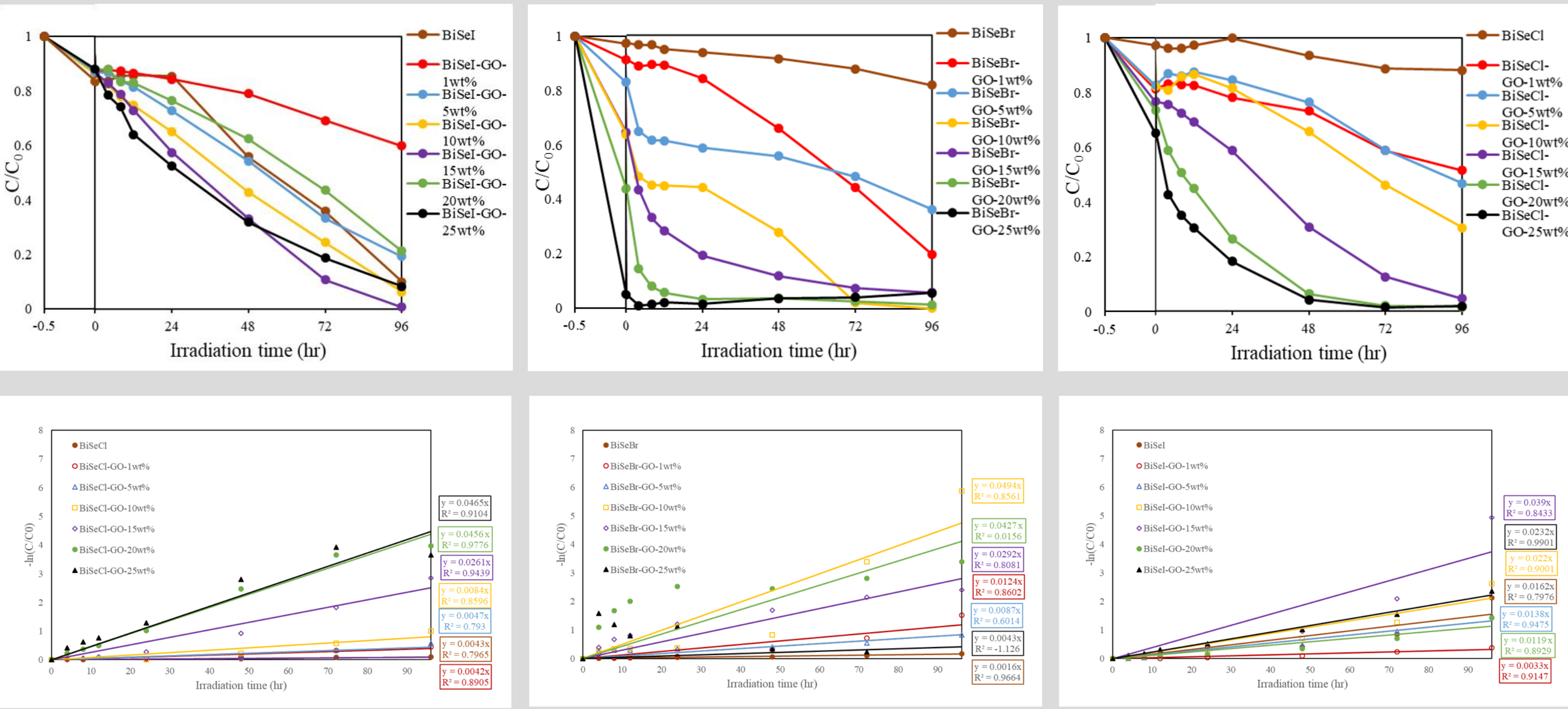


Fig.7 Photodegradation of CV as a function of irradiation time over different BiSeX-GO photocatalysts.

### FE-SEM-EDS

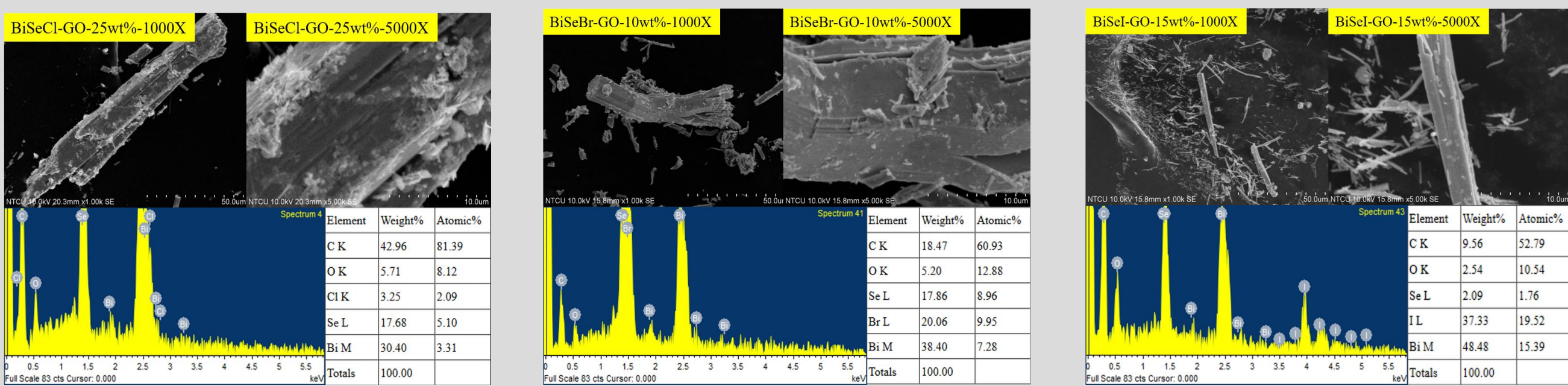


Fig.2 FE-SEM images and EDS of BiSeCl-GO-25wt%, BiSeBr-GO-10wt%, BiSeI-GO-15wt%.

### UV-Vis-NIR

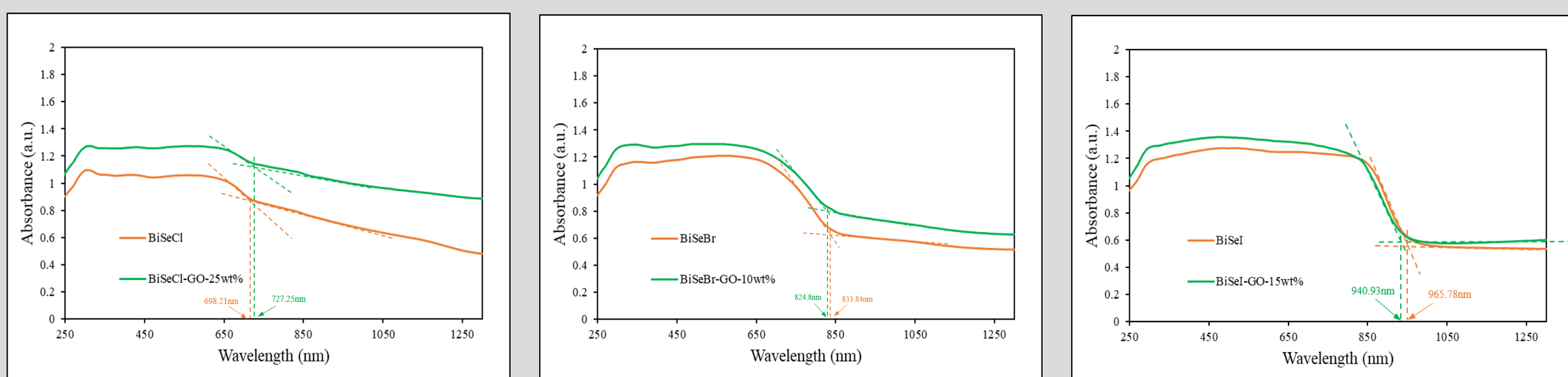


Fig.4 NIR pattern of BiSeCl-GO-25wt%, BiSeBr-GO-10wt%, BiSeI-GO-15wt%.

### BET

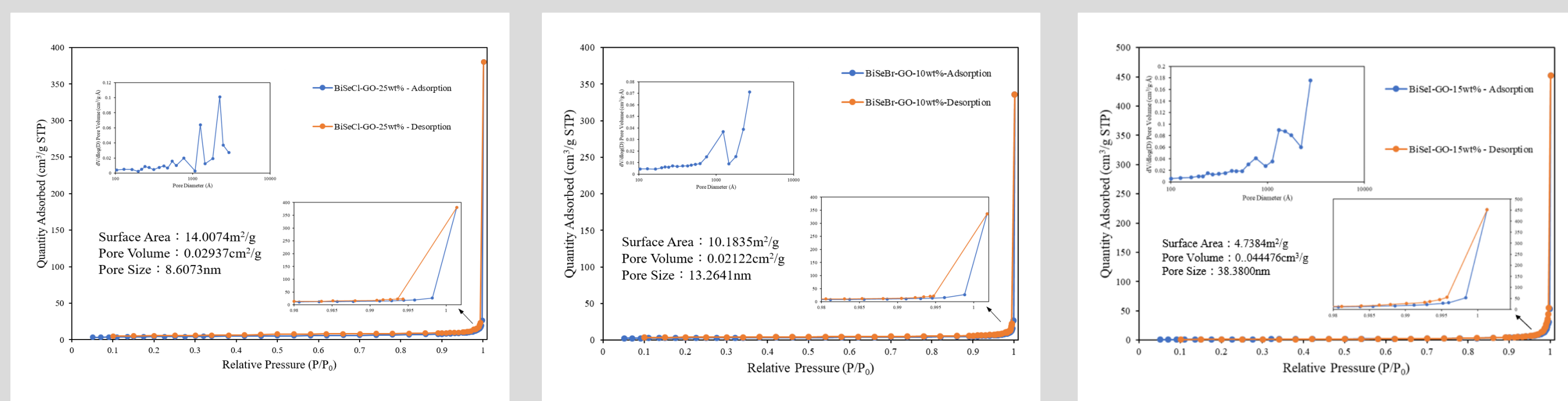


Fig.5 N<sub>2</sub> adsorption isotherm and pore size distribution of the BiSeCl-GO-25wt%, BiSeBr-GO-10wt%, BiSeI-GO-15wt%.

### Photodegradation reduction of CO<sub>2</sub>

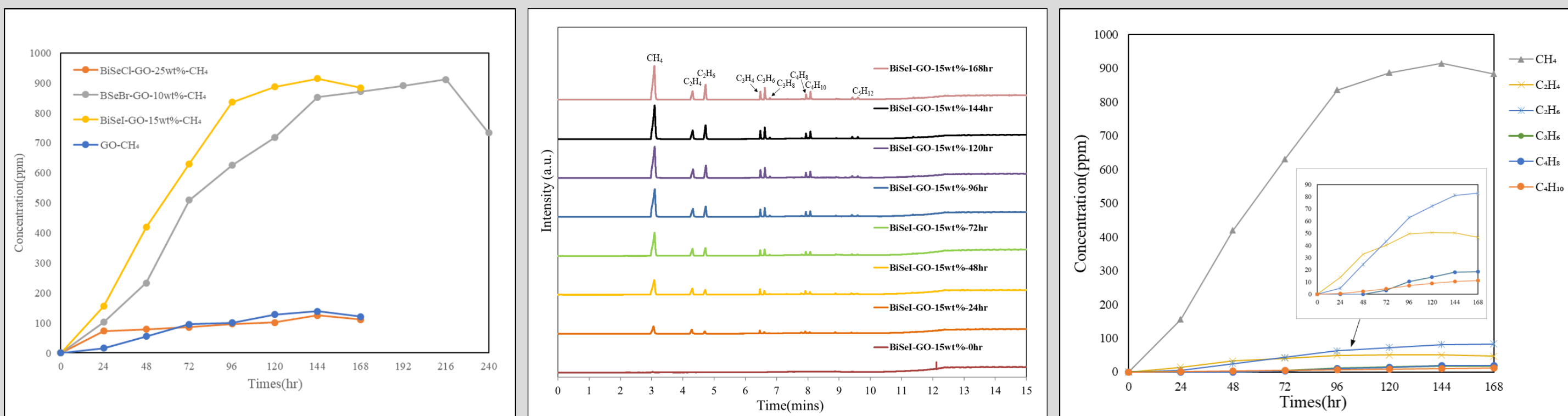


Fig.6 Photocatalytic reduction of CO<sub>2</sub> by BiSeX-GO and GO.

### PL

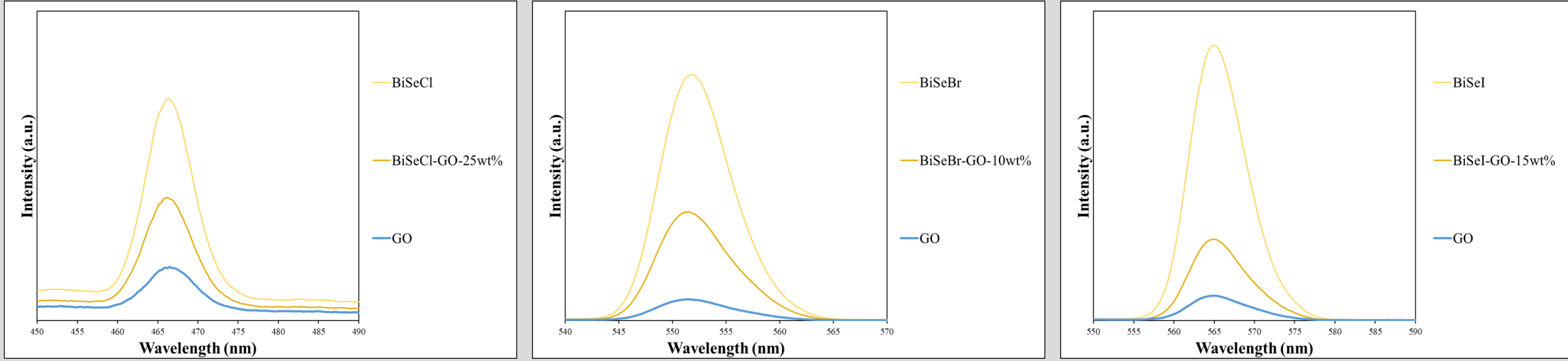


Fig.8 PL pattern of BiSeX, BiSeX-GO and GO.