**Raw Data and Data processing**

Raw data for ultraviolet–visible spectroscopy, photoluminescent and ultraviolet photoelectron spectroscopy has been uploaded for data transparency. All the data was plotted using Origin 9.1. The project files for data processing and data plotting have also been uploaded. To combine the plotted data into a manuscript figure, Adobe Illustrators were used for adjusting the layout. Below shows some important information for data processing in this work:

**Data for Fig1(d):**

Photoluminescent (PL) data was taken using SILVER-Nova Super Range TE Cooled Spectrometer. Using 514nm led excitation source with a 514nm notch filter to remove excitation signal. This Instrument could take the PL signal from 190nm-1100nm.

Data processing for PL:

**There is not extra data processing for PL**