Electronic Supplementary Material (ESI) for Environmental Science: Nano.


**Supporting Information**

# $Co_3O_4$-$C_3N_4$ p-n nano-heterojunctions for the simultaneous degradation of a mixture of pollutants under solar irradiation

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## Characterization of Materials

Thermal stability and compositions of the prepared photocatalysts are analyzed by thermo gravimetric analysis (Perkin Elmer STA 6000, USA) in the temperature range of 50-800 ° C at a heating rate of 5° C/ min in the air atmosphere. The crystal structure and phase purity of the prepared samples are obtained by X-ray diffraction (XRD) using a Philips X'pert Pro diffractometer in the 2θ range of 5-70° using Cu Kα radiation. X-ray photoelectron spectroscopy (XPS) is done on an ESCA + Omicron nanotechnology (Oxford instrument, Germany) spectrometer that is equipped with a Mg Kα X-ray source (hυ = 1253.6 eV). Morphology and microstructure of the prepared samples are investigated by high-resolution transmission electron microscope (HETEM, Technai $G^2$, FEI, and The Netherlands) at an accelerating voltage of 300 KV. The elemental composition of the samples is studied using energy dispersive spectrum (EDS) attached to the transmission electron microscope. The SEM EDS mapping is obtained from scanning electron microscope (Carl Zeiss, Germany). The Brunauer- Emmett- Teller (BET) surface area measurements are done by nitrogen adsorption (Micromeritics Tristar 2 USA surface area and porosity analyzer) after degassing at 200° C for 2 hrs. The UV- Visible absorption spectra of the prepared samples are recorded by a Shimadzu UV 2401 PC spectrophotometer in the range of 200- 800 nm and emission spectra are obtained from a spectrofluorometer (Cary Eclipse, Varian, The Netherlands). The prepared materials are also investigated by Fourier Transform Infrared (FT-IR) spectra using a Bruker FT-IR spectrometer for functional group identification. The photoluminescence spectrum was measured using a spectrofluorometer (Cary Eclipse, Varian, Netherlands). The photocatalytic degradations of tetracycline ((TC) and methylene

blue (MB) are monitored by a UV-visible spectrometer (UV 2401 PC, Shimadzu, Japan) at different time intervals.

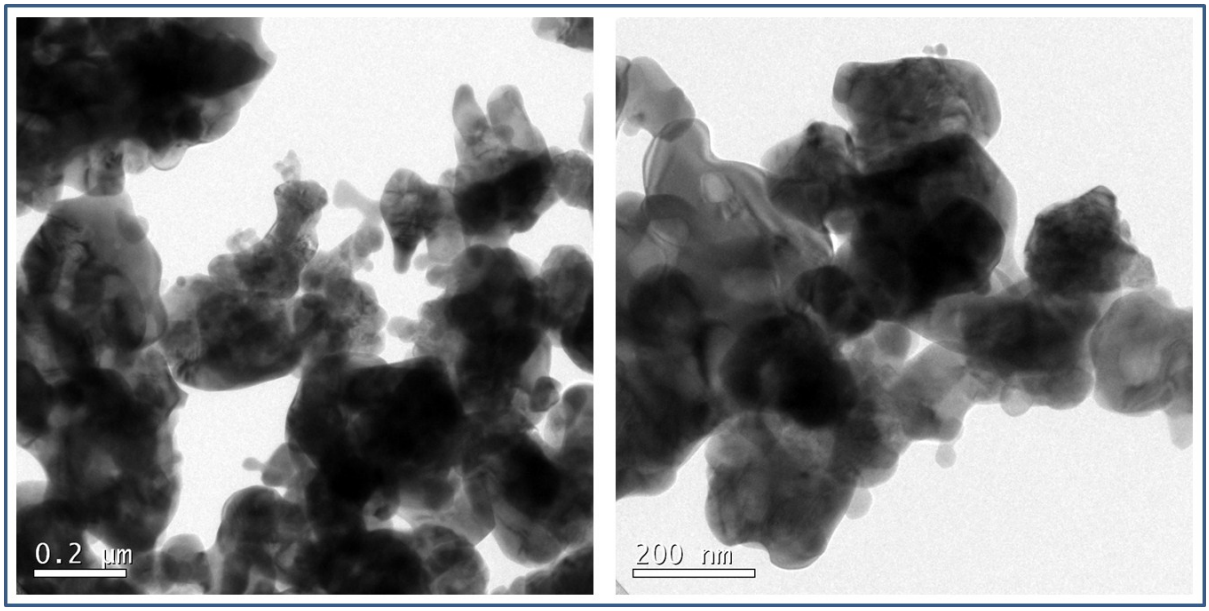


**Fig. S1** TEM images of CC0.7 composite

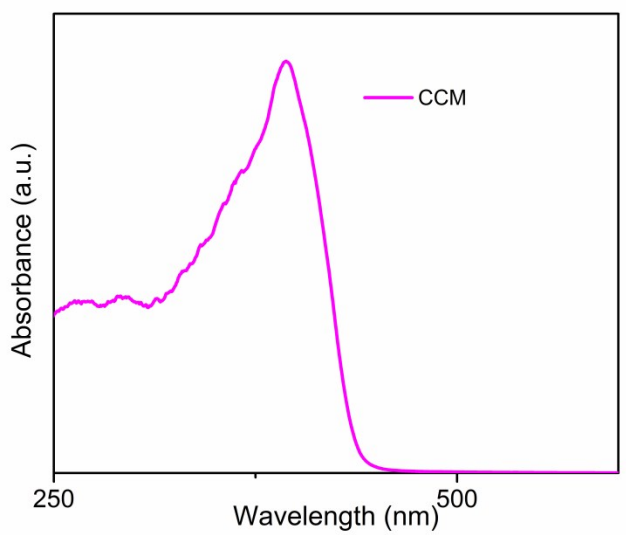


**Fig. S2** UV-Vis absorption pattern of mechanical mixture CCM.

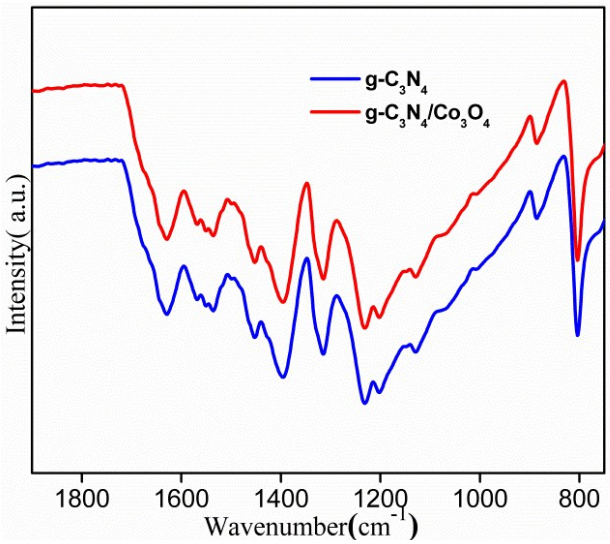


Fig. S3. FTIR spectra of g-$C_3N_4$/ $Co_3O_4$ (CC), $Co_3O_4$ and g-$C_3N_4$.

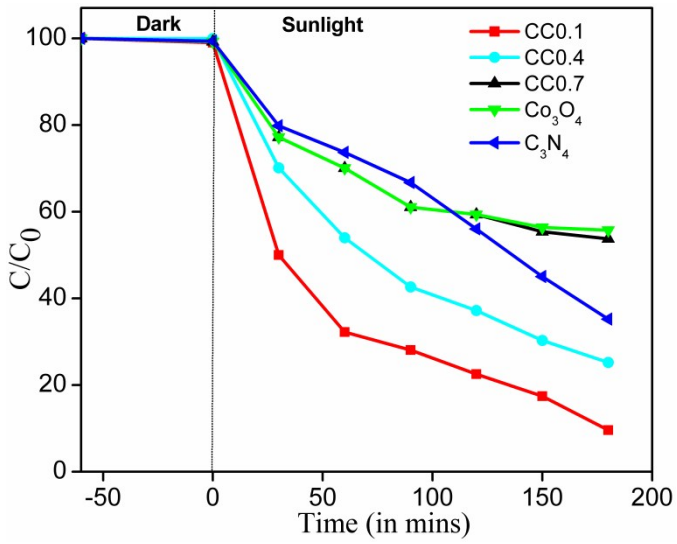


**Fig. S4** TC degradation profile of all the composites prepared, pristine $C_3N_4$ and $Co_3O_4$.

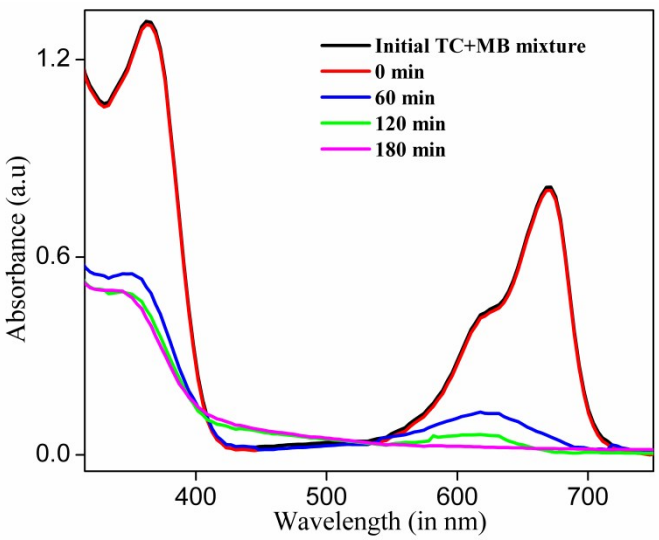


**Fig. S5** UV-Visible degradation patterns of TC and MB in the mixture using CC composite.

**Table S1:** Summary of summary of % degradation efficiency of CC, $C_3N_4$, and $Co_3O_4$

| **Sample** | **% Degradation** | | | |
|---|---|---|---|---|
| | **MB alone** | **MB in mixture** | **TC** | **TC in mixture** |
| CC | 90 (30 min) | 90 (90 min) | 97 (180 min) | 78 (180 min) |
| $C_3N_4$ | 70 (180 min) | 50 (180 min) | 55 (180 min) | 50 (180 min) |
| $Co_3O_4$ | 15 (180 min) | 15 (180 min) | 35 (180 min) | 30 (180 min) |

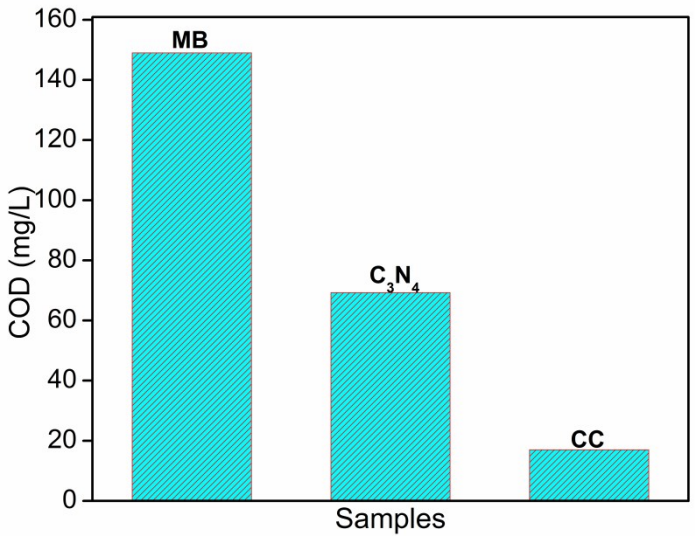


**Fig. S6** COD removal using CC, $C_3N_4$ and initial MB concentration**.**

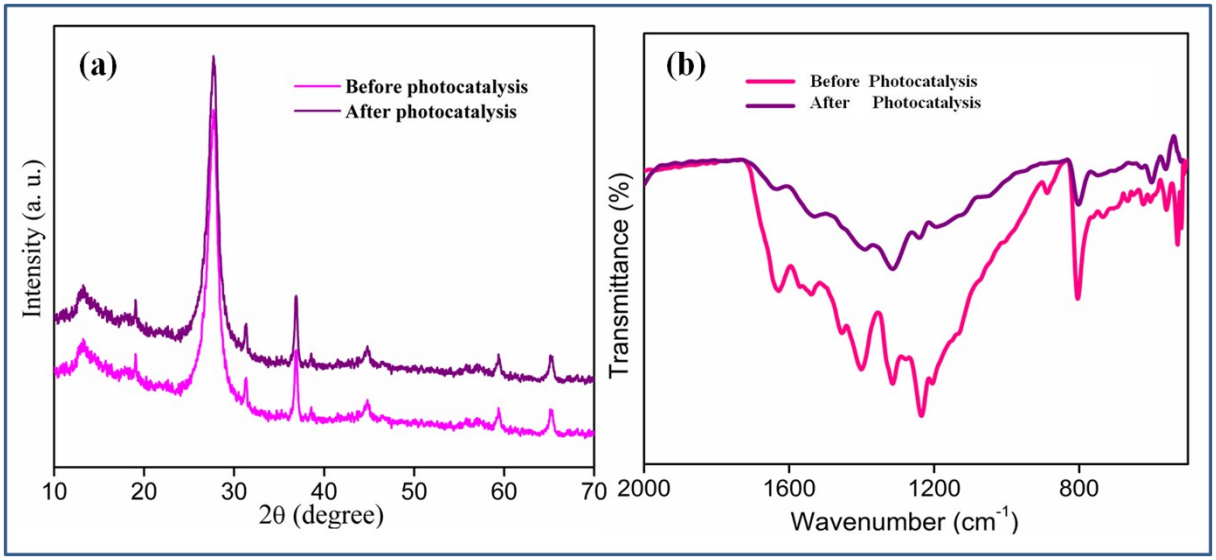


**Fig. S7** (a) XRD and (b) FTIR patterns of g-$C_3N_4$/ $Co_3O_4$ (CC) after the cyclic studies.

**Table S2.** Comparison of $C_3N_4$-$Co_3O_4$ systems reported earlier.

| Sample | Synthesis process | Wt% | Surface area | | Photocatalytic Activity | Ref |
|---|---|---|---|---|---|---|
| | | | $C_3N_4$ | Composite | | |
| $Co_xO_y$/CNS | Silica mediated mesoporous $C_3N_4$ and its mechanical mixtures with $Co_xO_y$ | 3 | _ | _ | Oxygen evolution reaction | 1 |
| $Co_3O_4$-g-$C_3N_4$ | Physical mixture | 0.2 | _ | _ | Methyl Orange degradation | 3 |
| mpg-$C_3N_4$-$Co_3O_4$ | Silica mediated mesoporous $C_3N_4$ and its mechanical mixtures with $Co_3O_4$ | 1.5 | 160 | 149 | Bisphenol-A degradation | 2 |
| $Co_3O_4$-g-$C_3N_4$ | Physical mixture | _ | _ | _ | Hydrogen evolution reaction | 4 |
| $C_3N_4$-$C_3O_4$-Co(III) Complex | Thermal condensation of dicyandiamide in CoCl2-containing eutectics | 3 | 1 | 51 | water oxidation and dye degradation | 5 |

| | | | | | | |
|---|---|---|---|---|---|---|
| g-$C_3N_4$/ $Co_3O_4$ | One-pot synthesis | 4 | 8 | 90 | Mixture of organic pollutant | Present study |

*****Note: blank space ( _ ) in the table indicates that the following data are not provided.

## References


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