Supporting information

Removal of hazardous material released from plastics, diethyl phthalate, by mesoporous graphitic carbon nitride boosted with ferrocene (Fc/g-C_3N_4) under visible light condition

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Home-made photoreactor system:

To the utilization of visible light irradiation, low-price as well as high-energy LEDs, we attempted to presented an acceptable batch optical system to detect the photocatalytic properties of our synthesized nanocomposite Fc/g-C_3N_4. The Beer–Lambert rule declares that the photon flux is straight corresponding to the distance, and the photon flux decreases with enhancing depth in the reaction medium. According to the stated facts, for photocatalytic reactions, it is very sensible that the reaction medium is near the irradiation source. We were assayed to design a united photoreactor that would introduce cooling, shaking, operational simplicity, and most importantly, highly matchable results. In this photo reactor system, a box that is completely covered with mirrors was employed, the reason for which is that the reflected light is not wasted and returns to the reaction medium. In order to integrate mixing, a commercial-available stirrer with 2300 rpm (IKA and Heidolph) with a magnet was applied in the middle of the box and around which it was used three LED lamps with different magnetic wavelengths with a power of 15W. A remarkable issue in the mentioned photo reactor system was the radiation of light from the side of the reaction medium. A distance of 6cm was improvised between the reaction medium and the LED array to absorb photons. In order to chill the reaction medium and LEDs, a fan was utilized outside the photoreactor. Some pictures of the home-made photoreactor are displayed in Figure S1.

Figure S1. The box including 15 W LED lamps as photoreactor systems

Materials and methods:

All commercially accessible beginning compounds were obtained by fundamental chemical manufactories, for examples, Acros Organic, Fluka, Merck, and Sigma-Aldrich which were utilized with no more purification. Solvents and substances were dehydrated previous to utilize. Various methods and analyses have been studied to identify the construction of prepared nanocomposites and synthesized compounds such as FT-IR test, spectral information, X-ray diffraction analysis (XRD), X-ray fluorescence (XRF), scanning electron microscope (SEM), high-resolution transmission electron microscopy (HR-TEM), energy dispersive X-ray analysis (EDX), UV-visible DRS and photoluminescence analysis, X-ray photoelectron spectroscopy (XPS), cyclic voltammetry, photocurrent, and electrochemical impedance spectroscopy analyses and Brunauer-Emmett-Teller surface area analysis (BET). Fourier-transform infrared spectroscopies were provided on a Tensor II Bruker spectrometer utilizing potassium bromide (KBr) pellet in the frequency range between 400 to 4000 (ν in cm^{-1}). The XRFs were recorded on Unisantis XMF 104. The EDX analyses were obtained by TESCAN-Vega 3. Fluorescence spectroscopy were run by Varian Cary Eclipse. UV-visible DRS was run by Jasco V-670 absorption spectrometer. Cyclic voltammetry, electrochemical impedance spectroscopy and photocurrent were investigated with auto lab 84490. To determine the X-ray diffraction pattern of the g-C_3N_4 and Fc/g-C_3N_4, XRD technique was followed by applying for Bruker D-8 ADVANCE with a CuKa irradiation source (1.5406 Å). The 2θ angle was scanned at a rate of 1.5 °/ min within the 2θ = 5-90°. The synthesized g-C_3N_4 and Fc/g-C_3N_4 were characterized by transmission electron microscopy (TEM) with Tecnai G2 F30 Manufacturer: Dutch FEI Company and scanning electron microscopy (SEM) with Sirion 200 Manufacturer: Dutch FEI Company. The XPSs of the g-C_3N_4 and Fc/g-C_3N_4 were characterized on a AXIS SUPRA+ Manufacturer: Shimadzu-Kratos, Japan. BET analysis was studied by Belsorp mini II from Microtrac Bel Corp company. High-performance liquid chromatography (HPLC, AZURA, KNAUER, Germany). The confocal Raman spectroscopy was recorded by Lab Ram HR (Horiba company, Japan).

General procedure for preparation modified with g-C_3N_4 and Fc/g-C_3N_4 and unmodified CPEs:

Firstly, the carbon paste electrode (CPE) was produced by hand blending graphite powder and mineral oil in a ratio of 12 mg:6 mg for 1 hour in an agate pounder to get a carbon paste. The achieved CPE was filled into the homemade Teflon cavity and electrical contact was provided by copper wire at the end of the PVC tube. The surface of CPEs was cleaned by rubbing their outer surface on a piece of paper before use. The modified CPEs with g-C_3N_4 and Fc/g-C_3N_4 were produced in the same method, 2mg g-C_3N_4 and nanocomposite Fc/g-C_3N_4 were added to the graphite powder (12mg) and mineral oil (6mg) in the initial step.

Photoelectrochemical measurements

The photocurrent was run on an electrochemical instrument in a standard three-electrode with a Pt wire as the working electrode, FTO as the counter electrode and Ag/AgCl (sutured KCl) as a reference electrode. A Xe arc lamp *via* a UV-separator filter (λ> 400 nm) was used as a light source with an intensity of 0.6 V applied potential. Na_2SO_4 (0.5 M) aqueous solution was used as the electrolyte.

HPLC method:

HPLC system was recorded utilizing LC-18 column (250 mm × 0.6 mm, 5 µm) with an injection volume of 5 µL. The mobile phase in methanol-water (65:35, v/v) at a flow rate of 1 mL/min was applied to LC-18 column. The temperature of HPLC column thermostat was maintained at 30°C and the wavelength of UV detector was fixed at 224 nm.

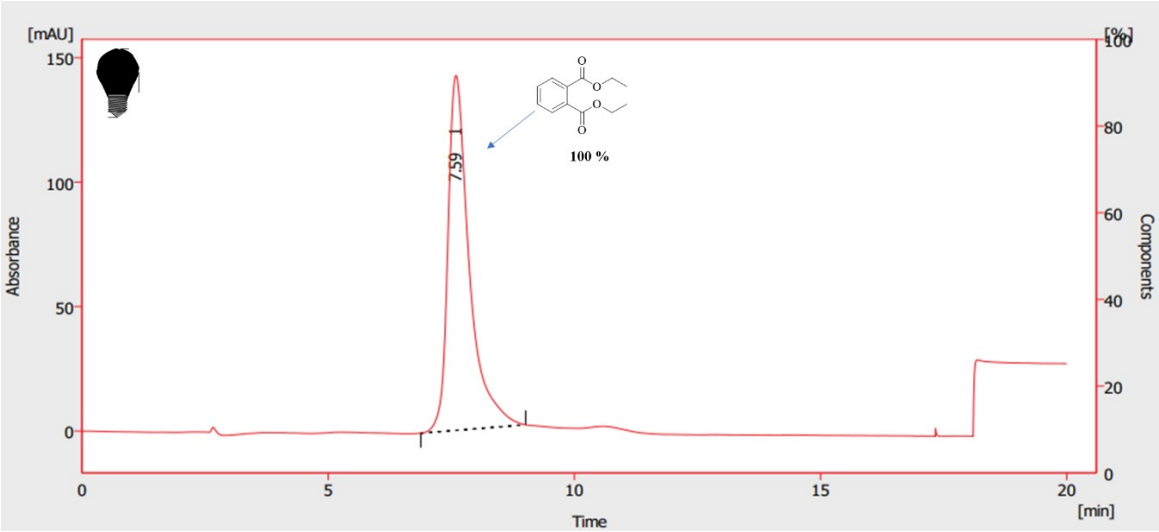


Figure S2. Photodegradation of DEP under dark after 30 min

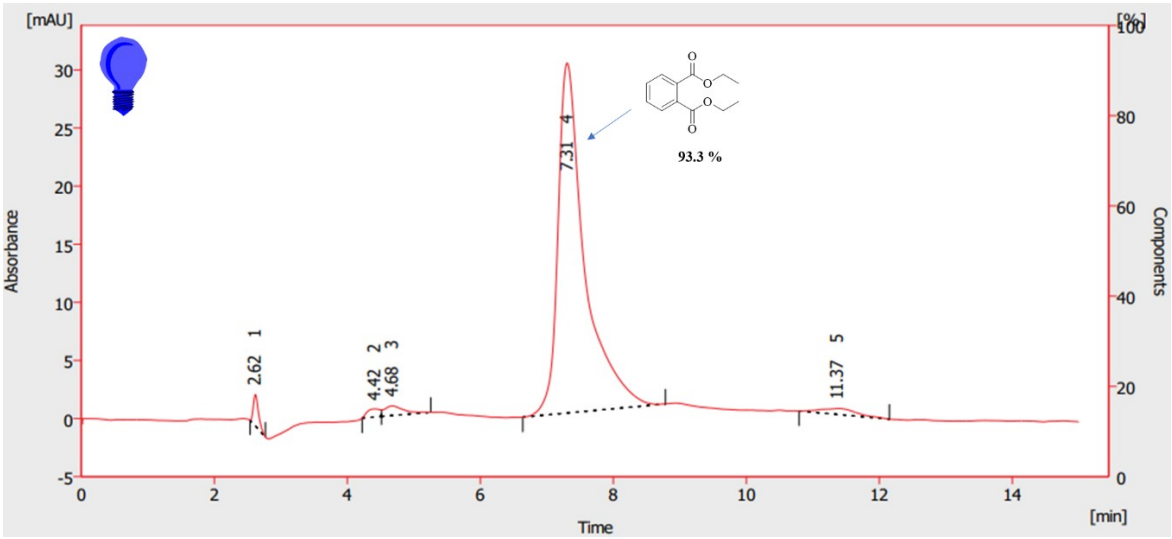


Figure S3. Photodegradation of DEP with g-C_3N_4 under blue LED after 30 min

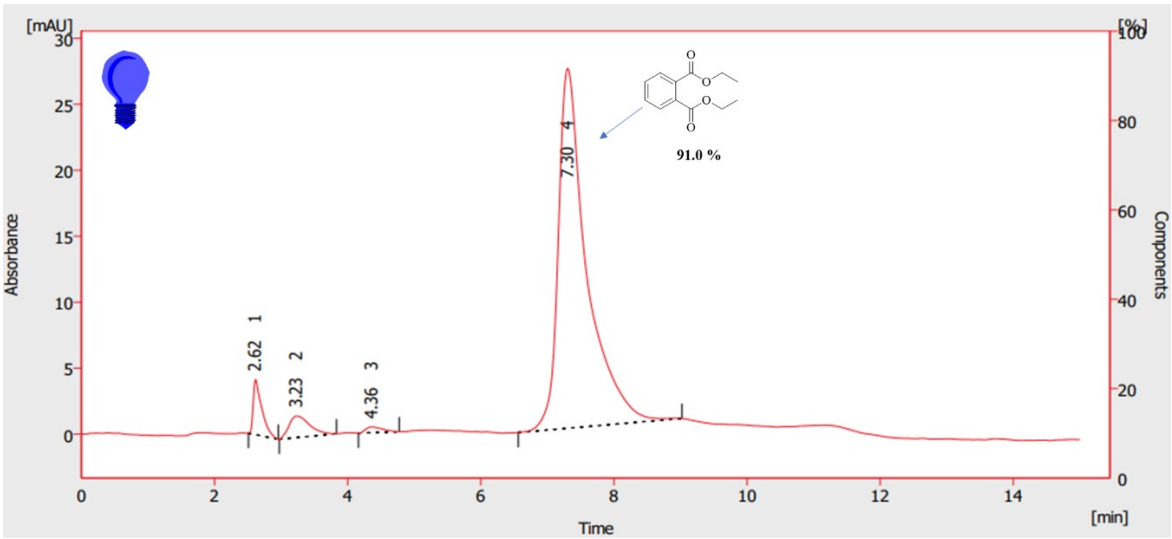


Figure S4. Photodegradation of DEP with g-C_3N_4 under blue LED after 60 min

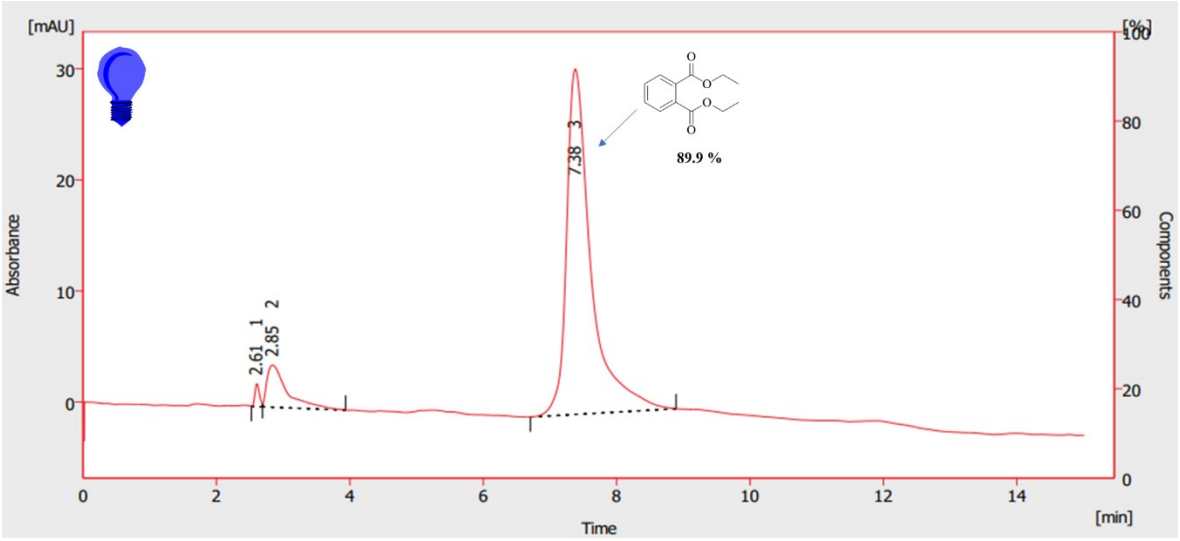


Figure S5. Photodegradation of DEP with g-C_3N_4 under blue LED after 120 min

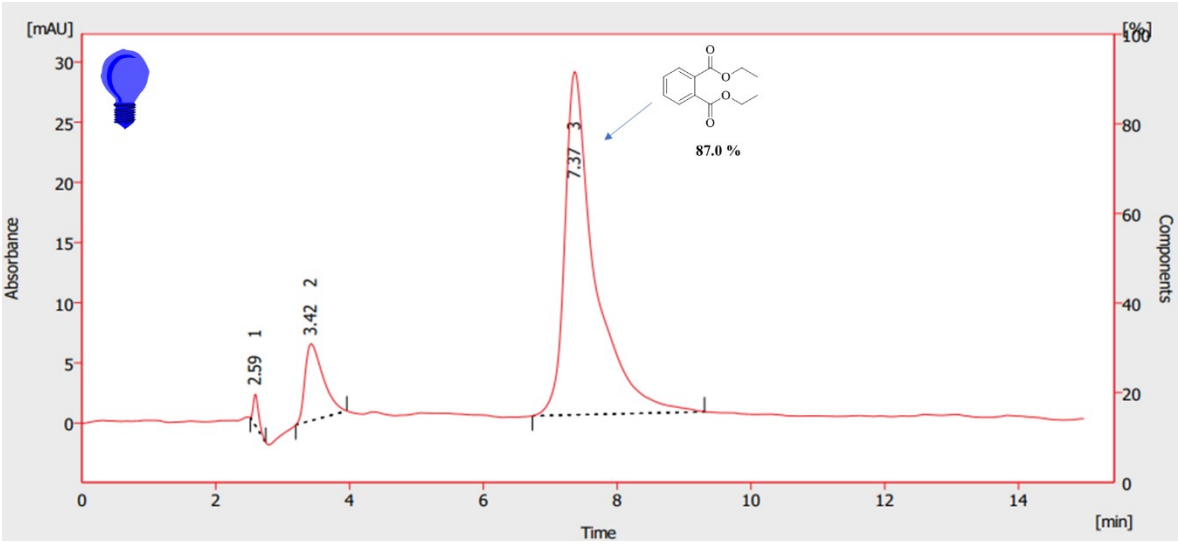


Figure S6. Photodegradation of DEP with g-C_3N_4 under blue LED after 180 min

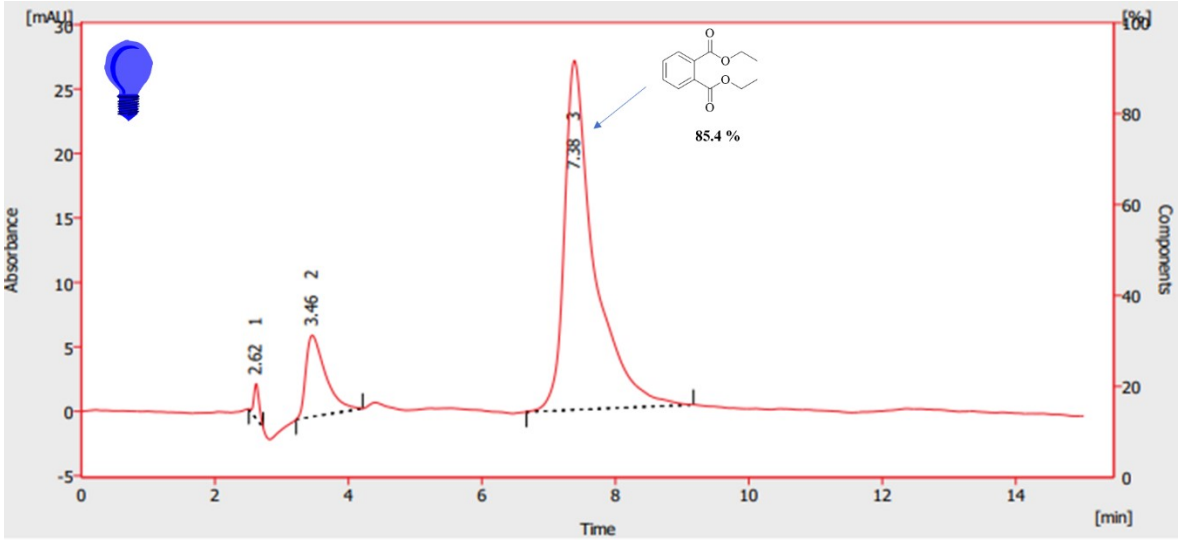


Figure S7. Photodegradation of DEP with g-C_3N_4 under blue LED after 240 min

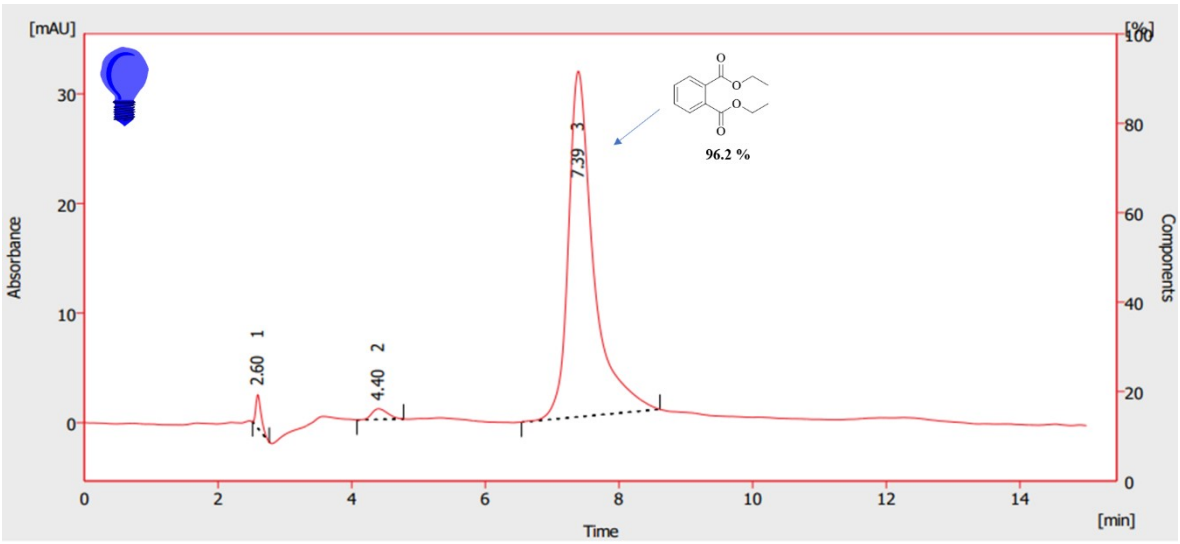


Figure S8. Photodegradation of DEP with Fc/g-C_3N_4 under blue LED after 30 min

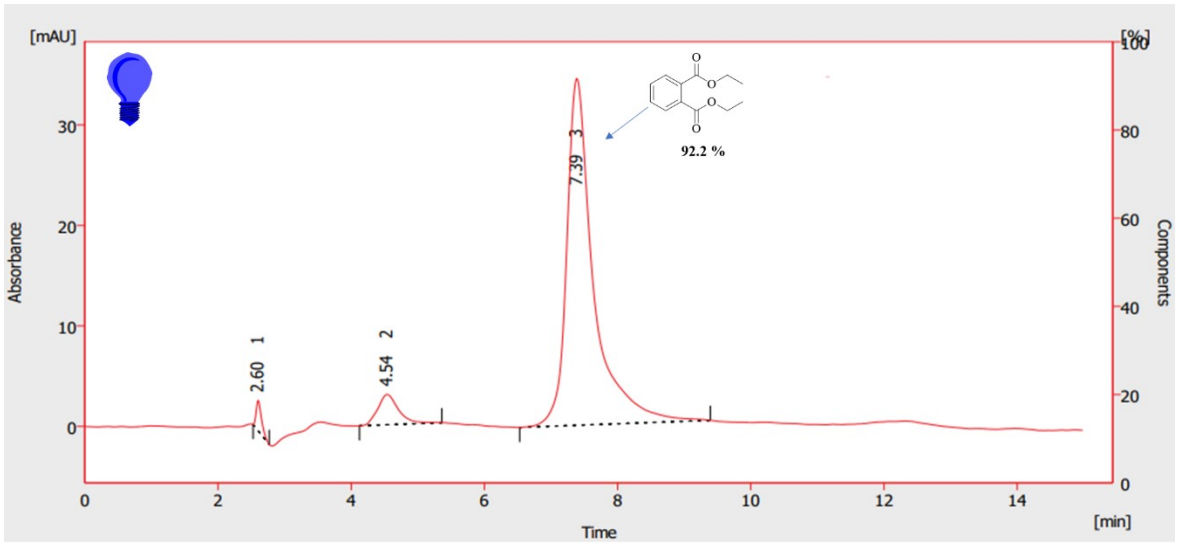


Figure S9. Photodegradation of DEP with Fc/g-C_3N_4 under blue LED after 60 min

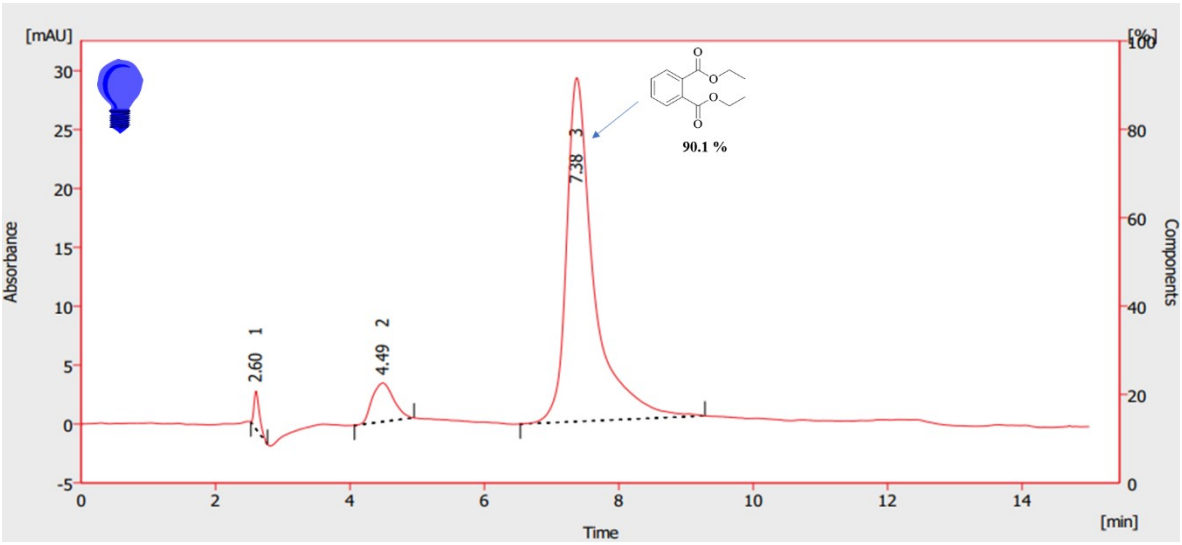


Figure S10. Photodegradation of DEP with Fc/g-C_3N_4 under blue LED after 120 min

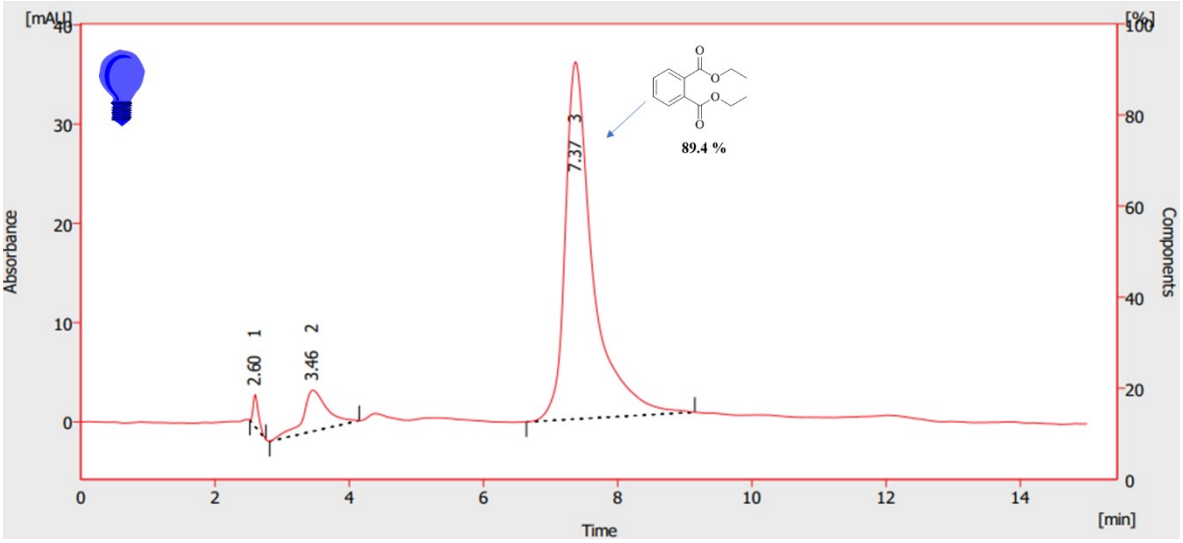


Figure S11. Photodegradation of DEP with Fc/g-C_3N_4 under blue LED after 180 min

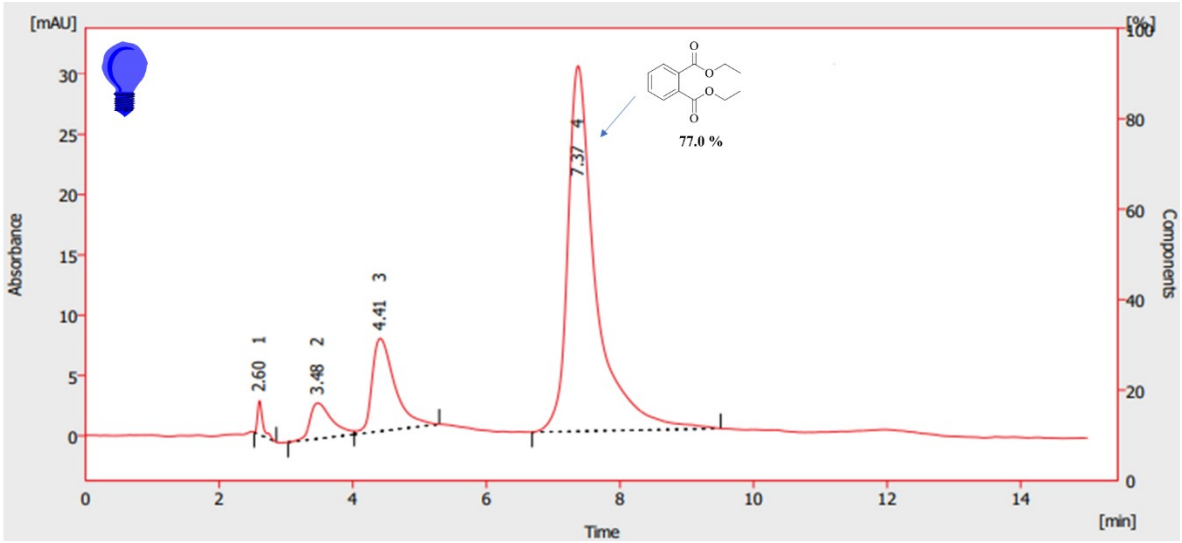


Figure S12. Photodegradation of DEP with Fc/g-C_3N_4 under blue LED after 240 min

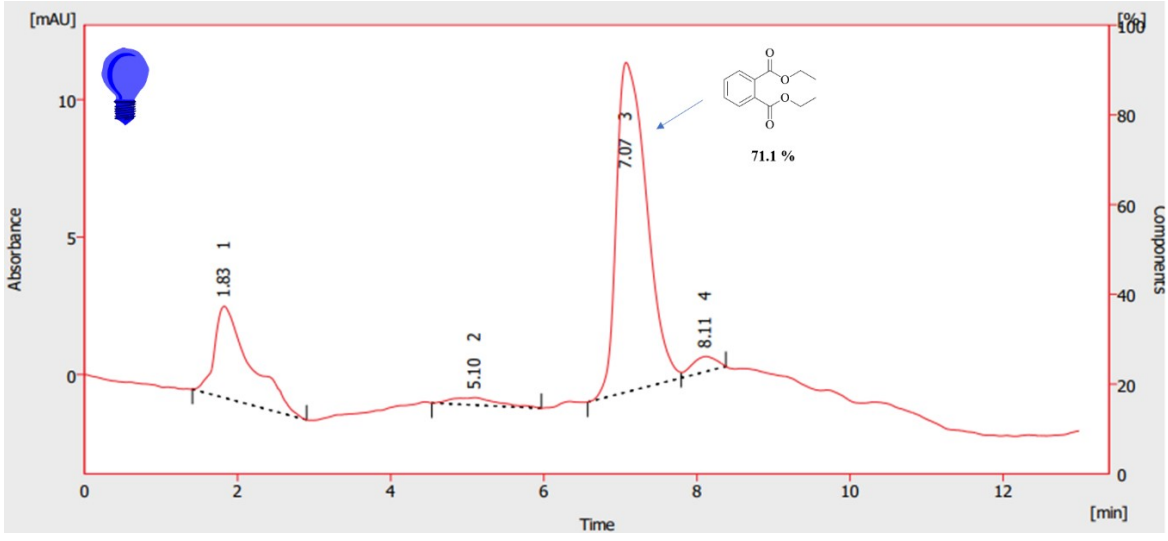


Figure S13. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under blue LED after 30 min

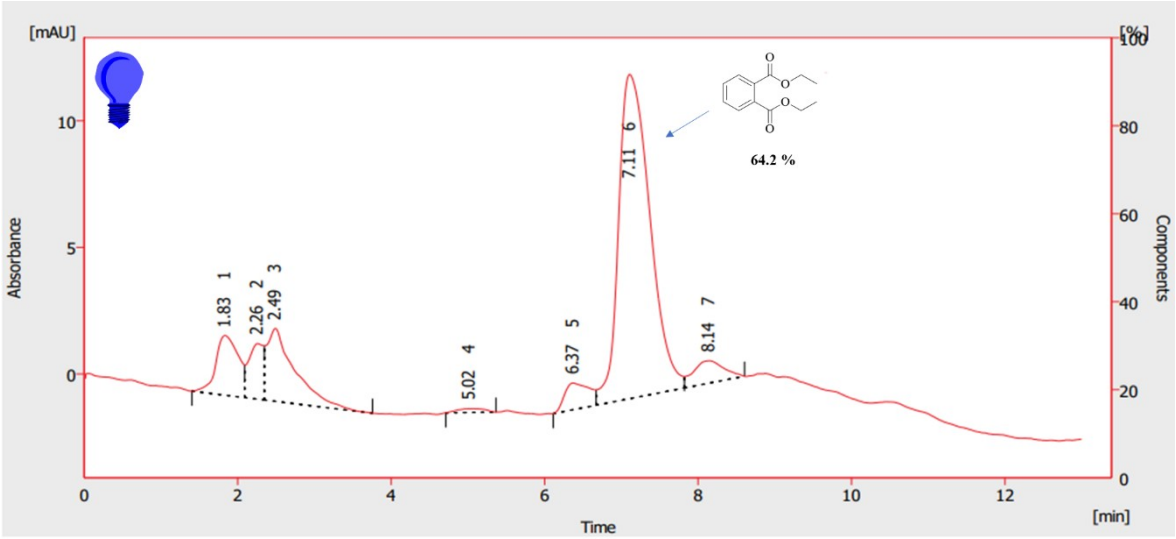


Figure S14. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under blue LED after 60 min

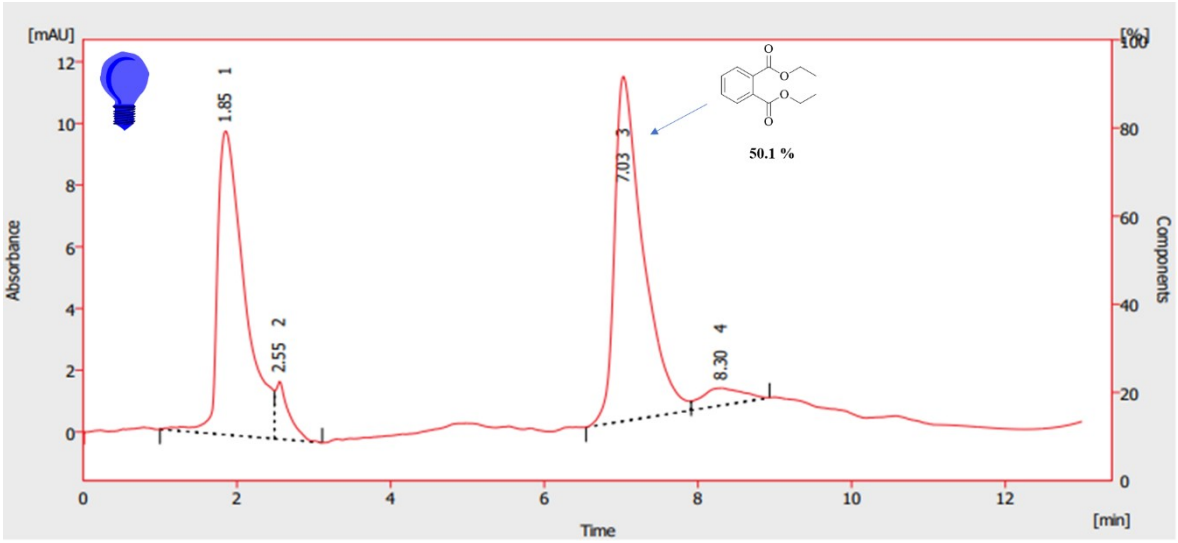


Figure S15. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under blue LED after 120 min

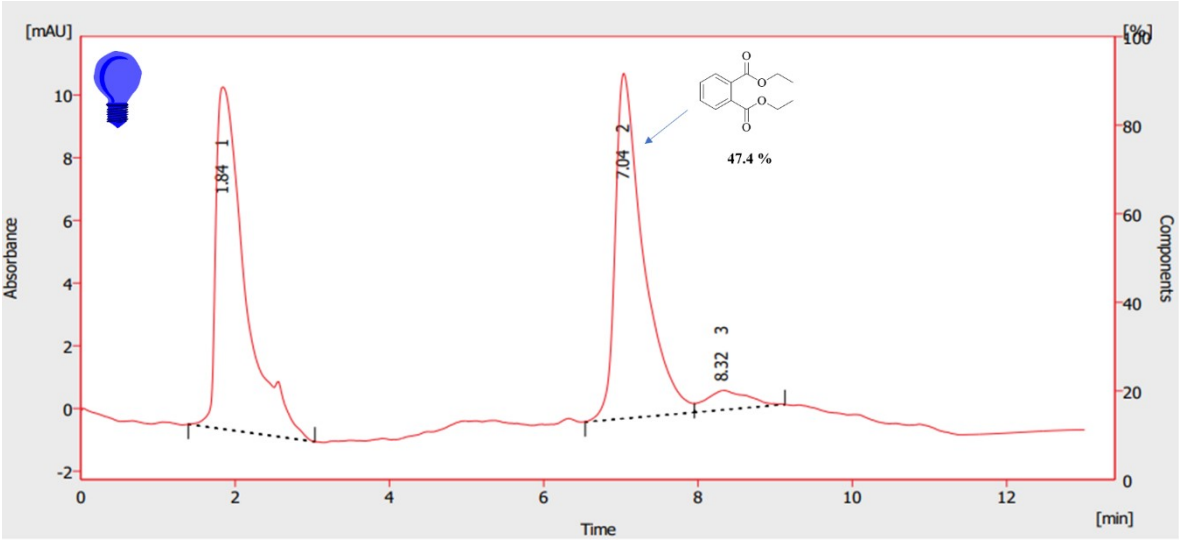


Figure S16. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under blue LED after 180 min

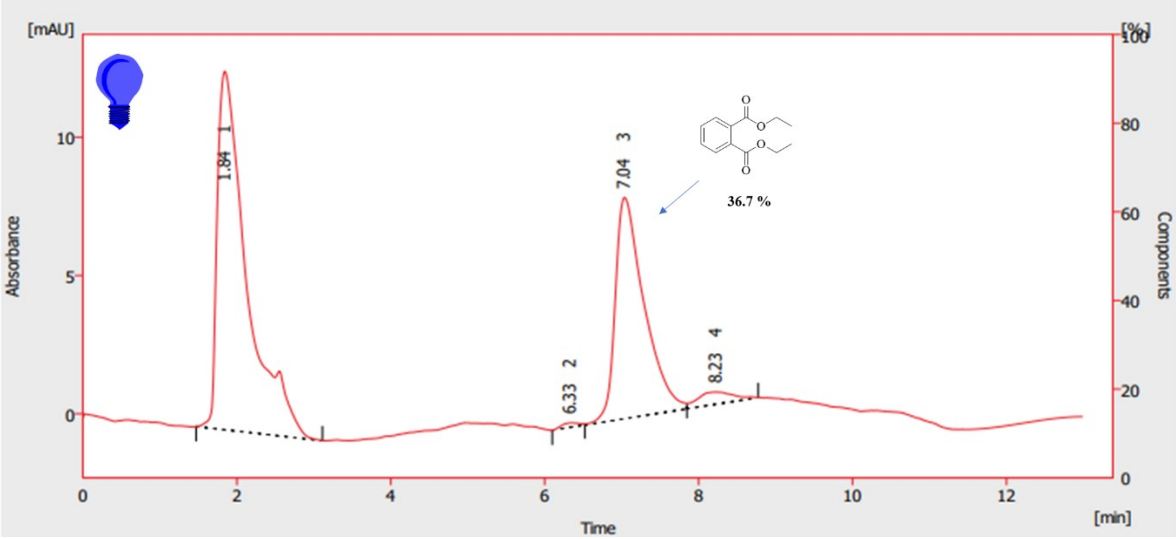


Figure S17. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under blue LED after 240 min

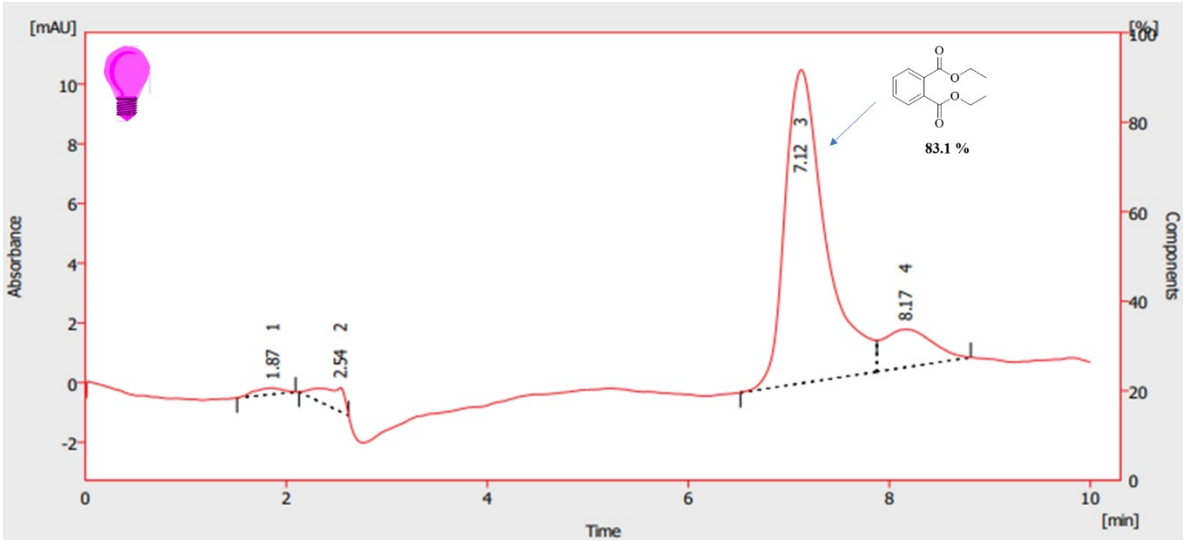


Figure S18. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under violet LED after 30 min

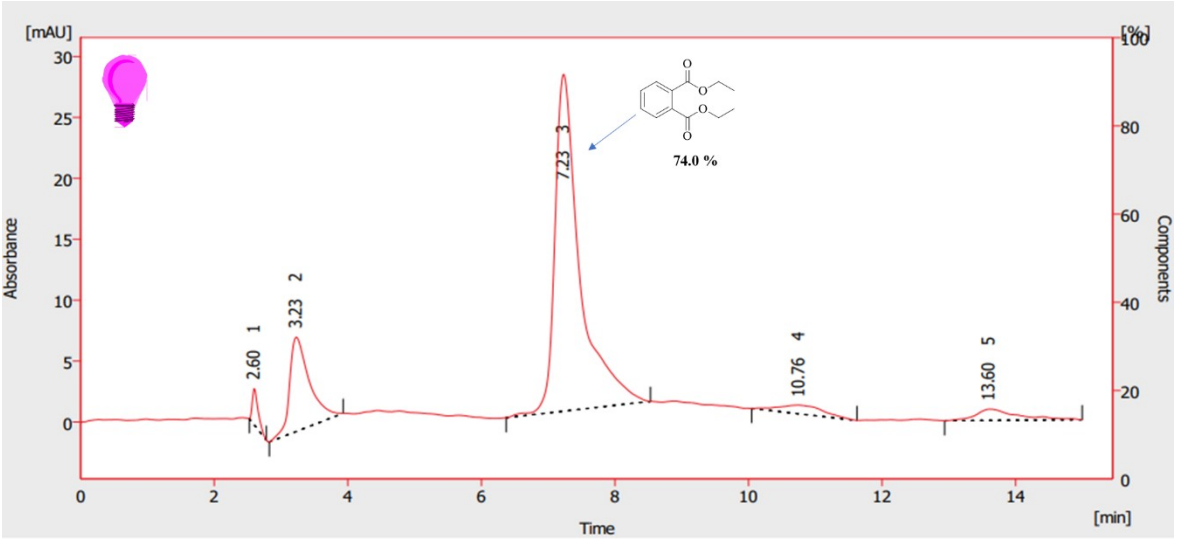


Figure S19. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under violet LED after 60 min

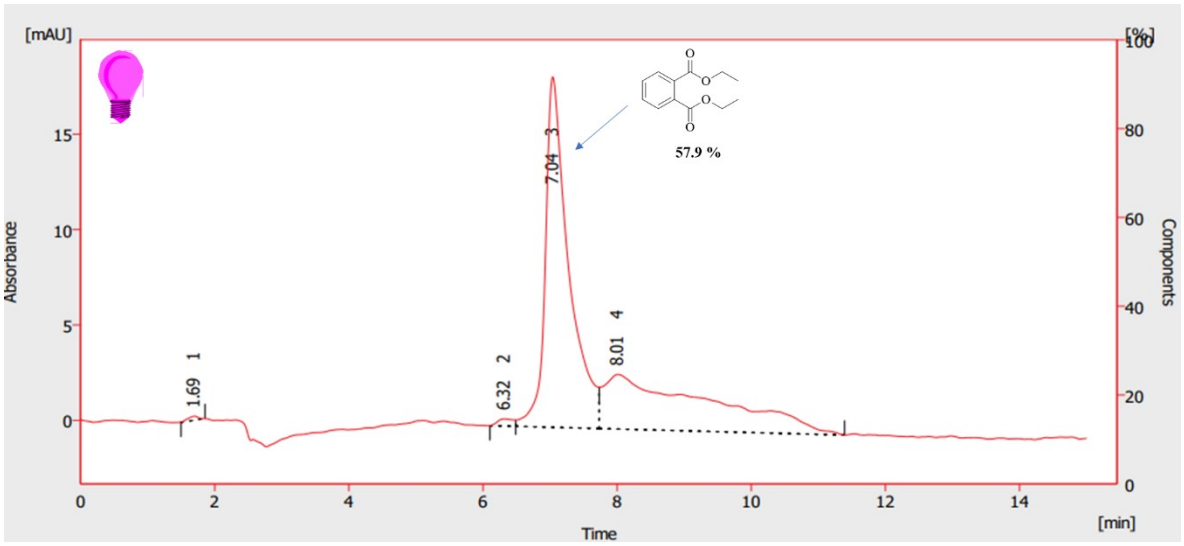


Figure S20. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under violet LED after 120 min

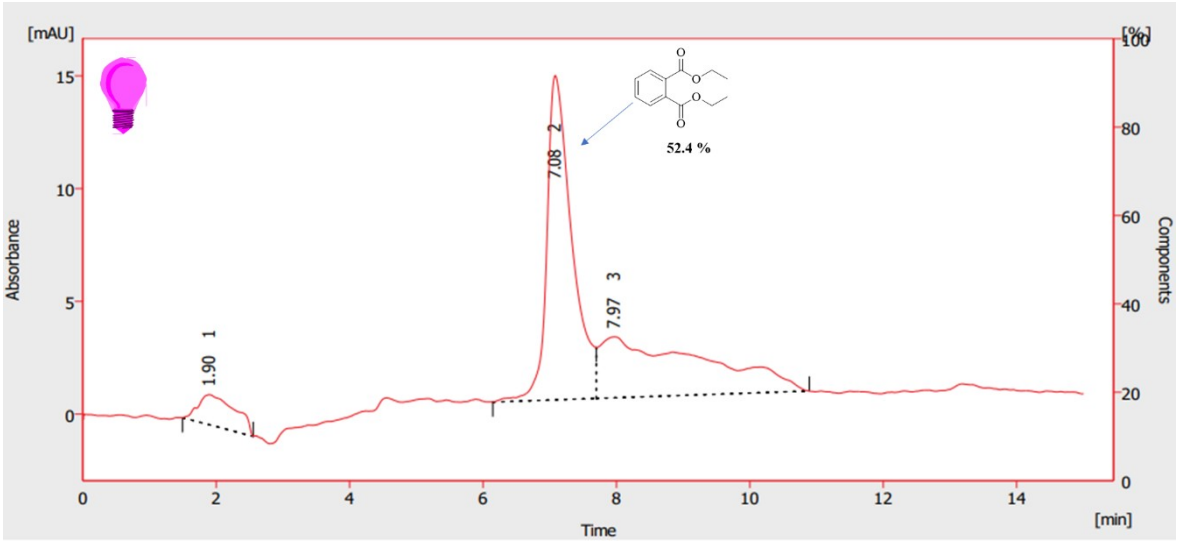


Figure S21. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under violet LED after 180 min

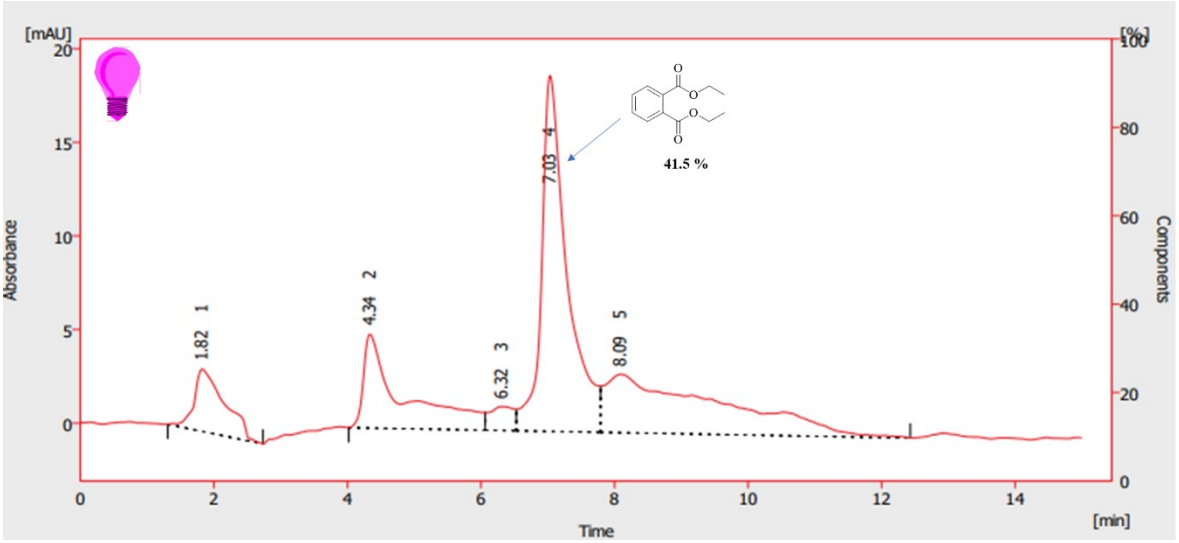


Figure S22. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under violet LED after 240 min

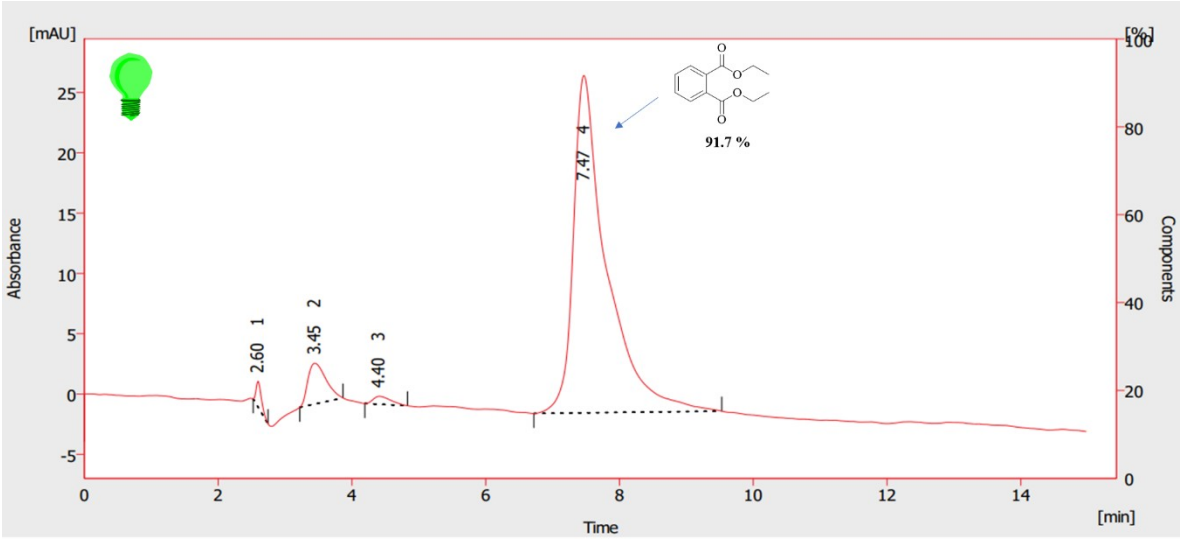


Figure S23. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under green LED after 30 min

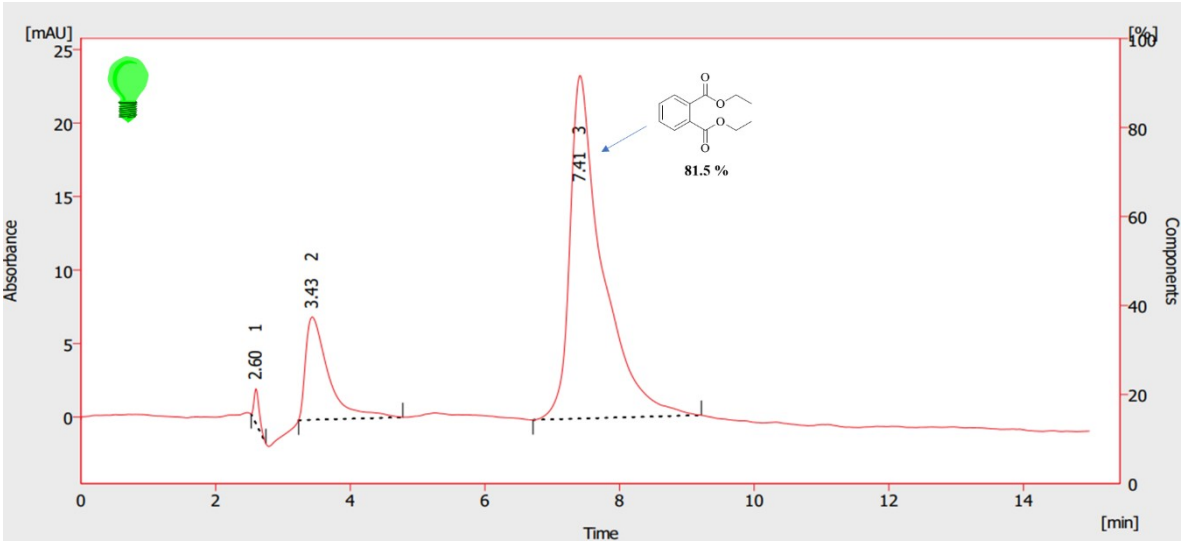


Figure S24. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under green LED after 60 min

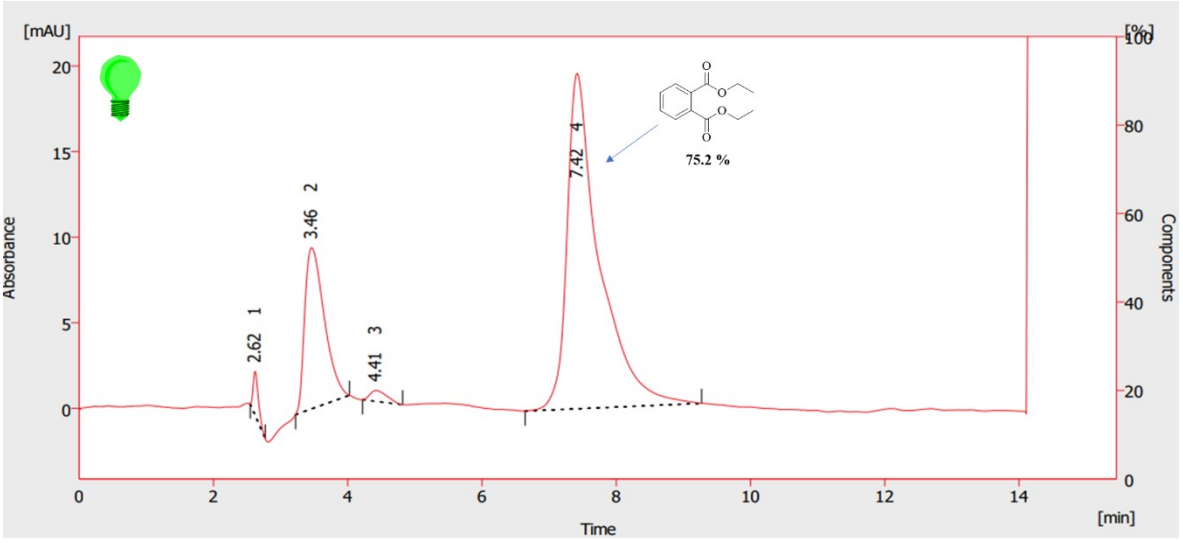


Figure S25. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under green LED after 120 min

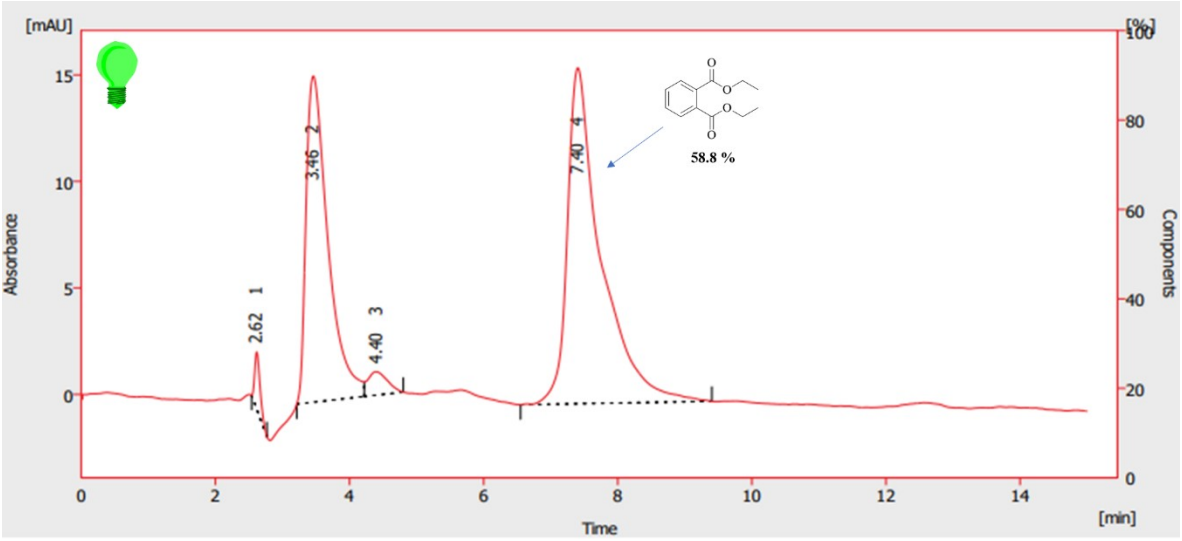


Figure S26. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under green LED after 180 min

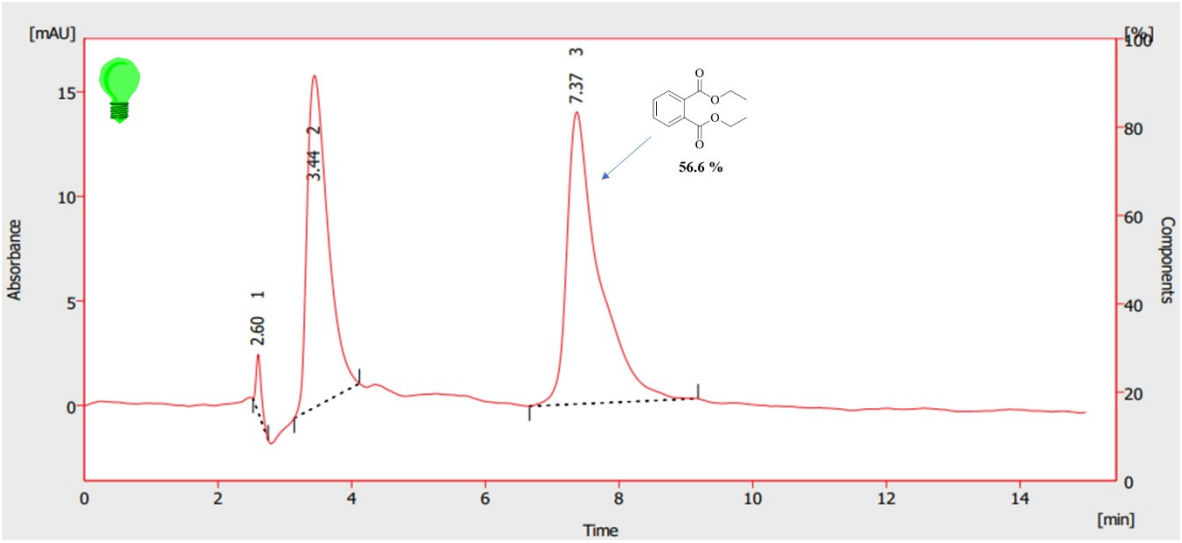


Figure S27. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under green LED after 240 min

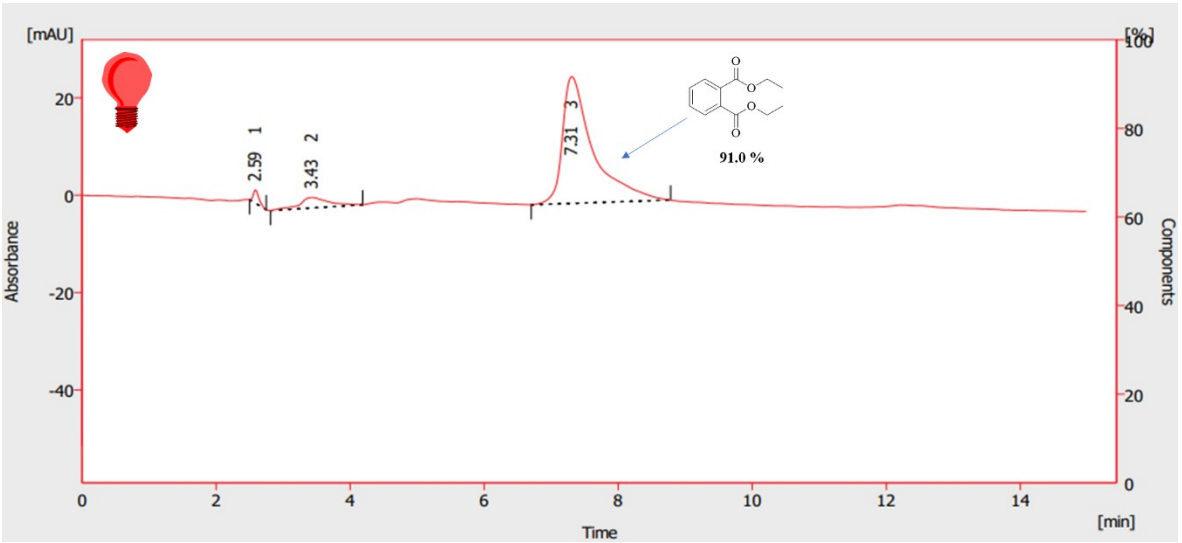


Figure S28. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under red LED after 30 min

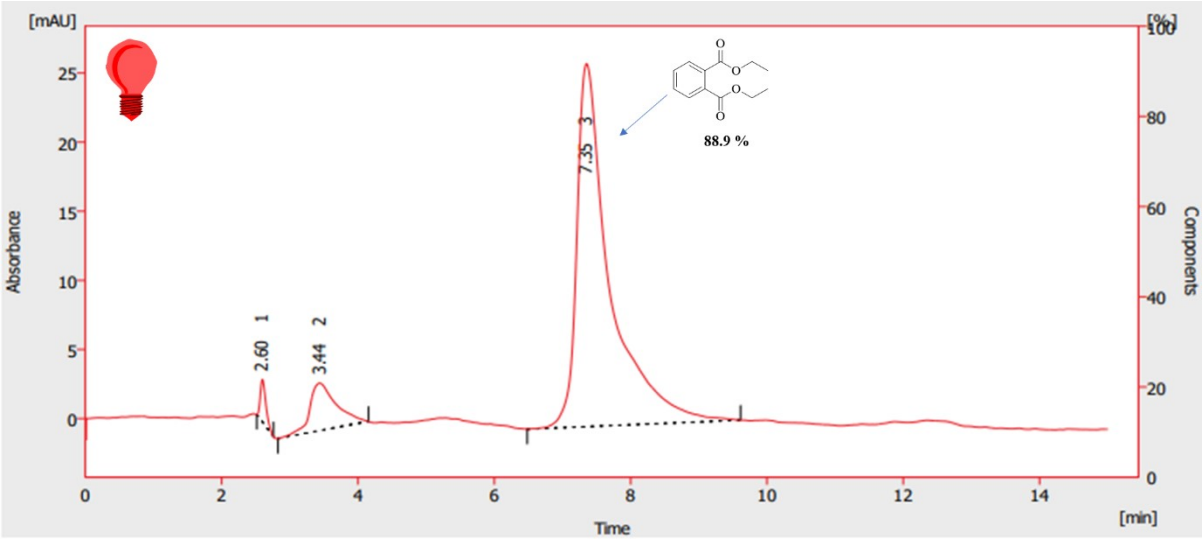


Figure S29. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under red LED after 60 min

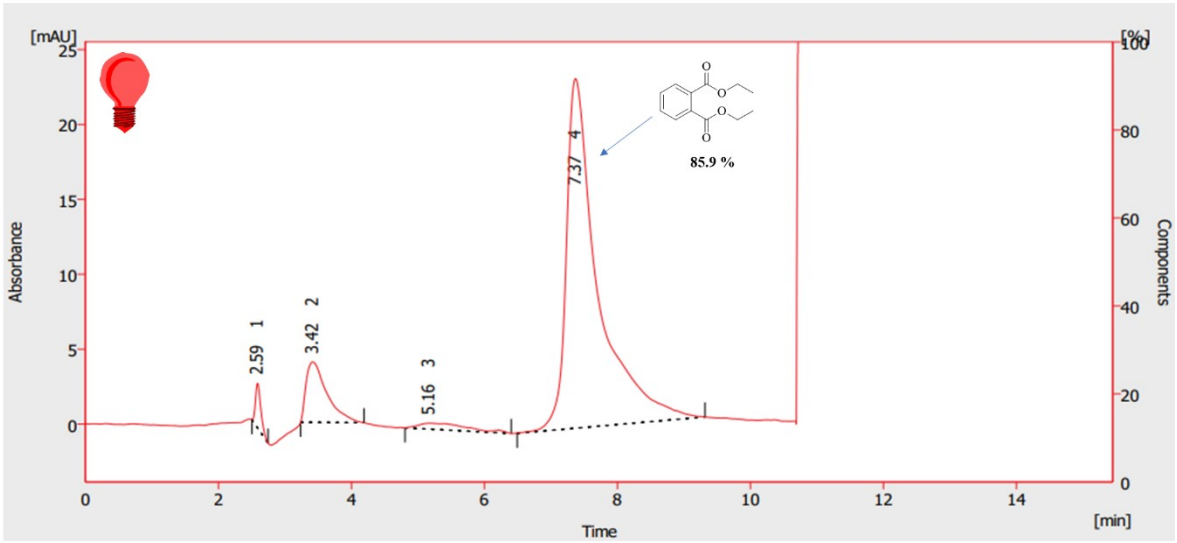


Figure S30. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under red LED after 120 min

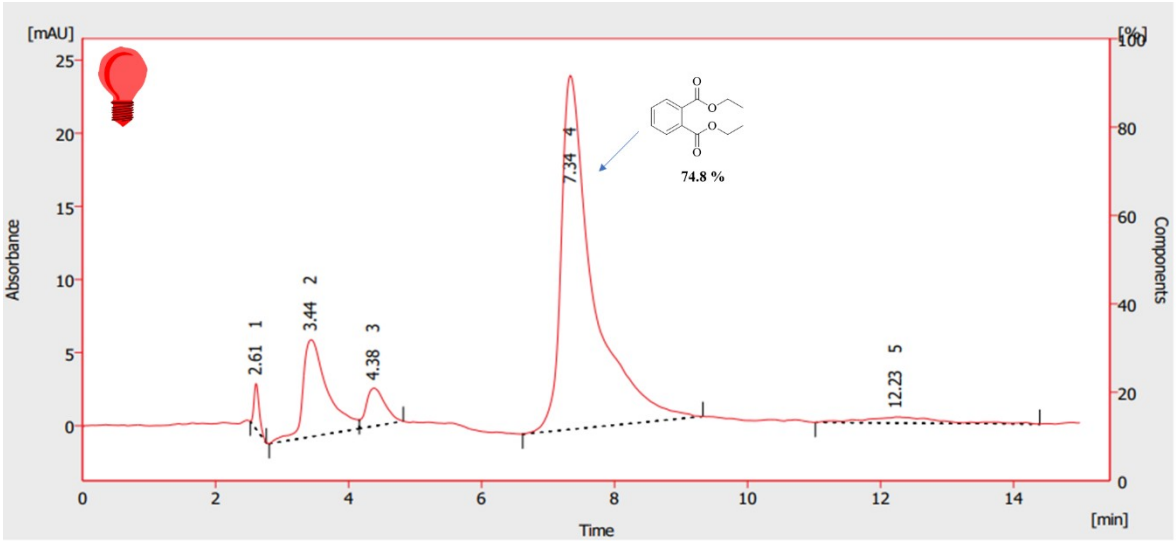


Figure S31. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under red LED after 180 min

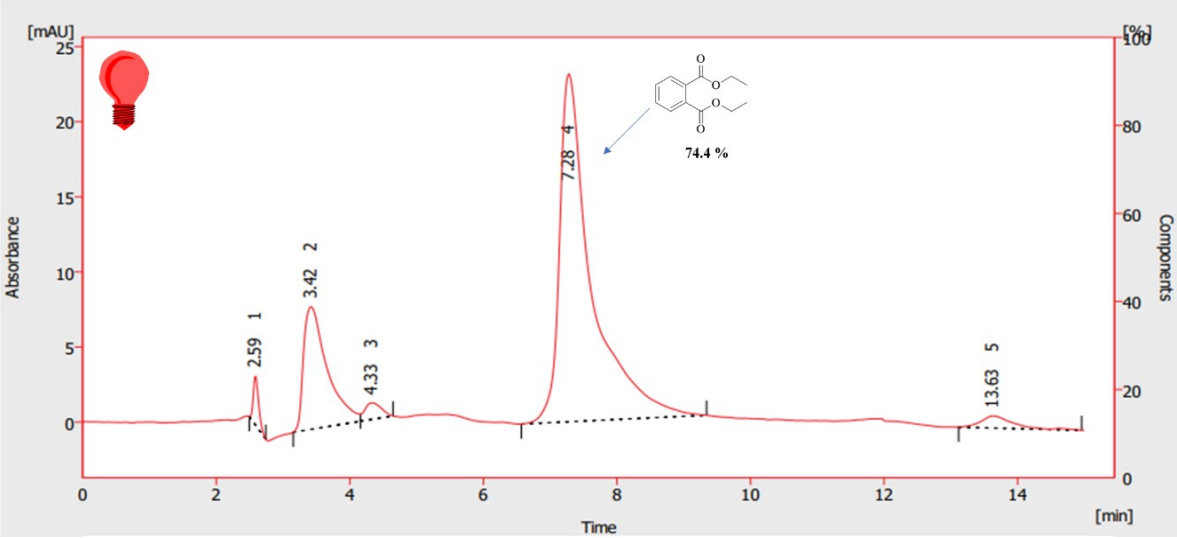


Figure S32. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under red LED after 240 min

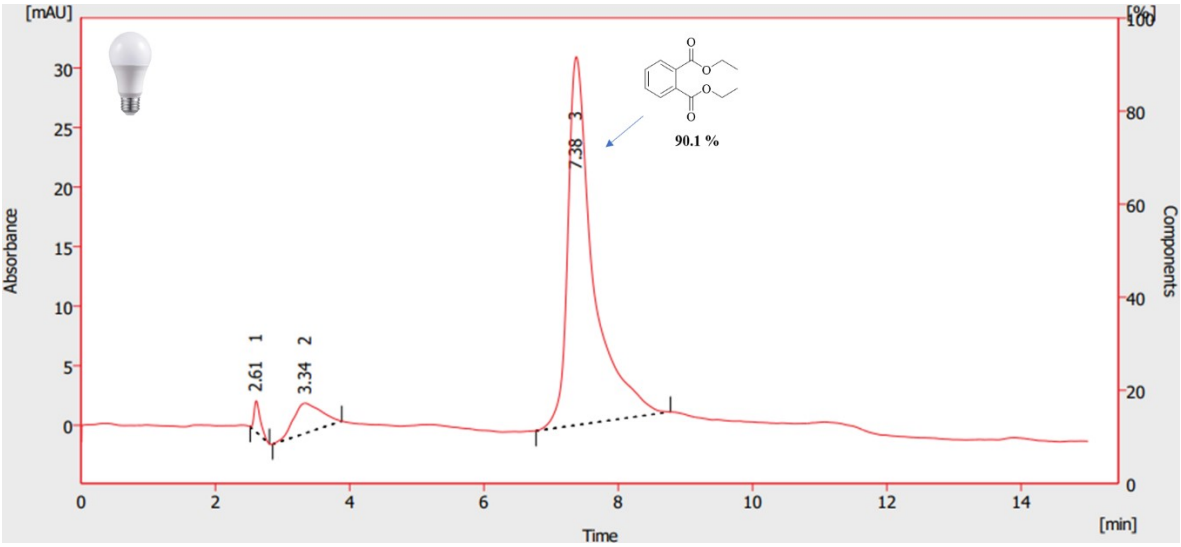


Figure S33. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under white LED after 30 min

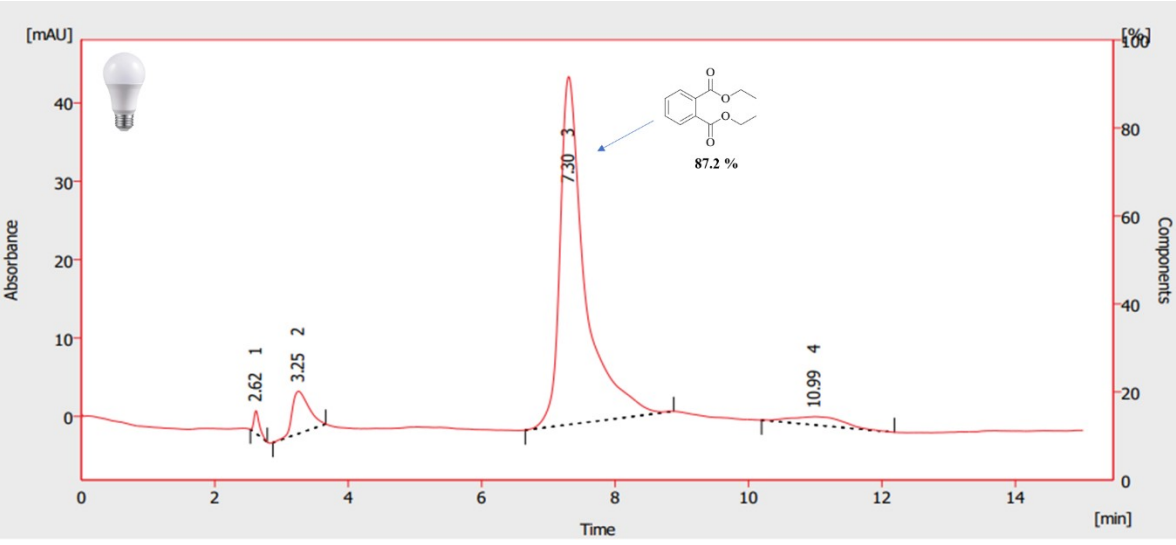


Figure S34. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under white LED after 60 min

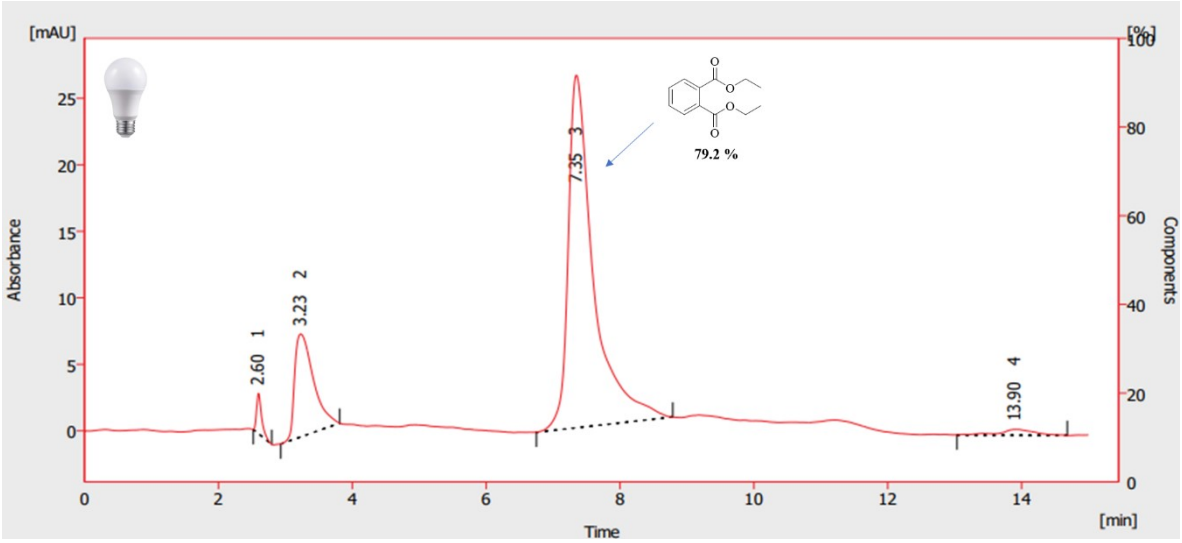


Figure S35. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under white LED after 120 min

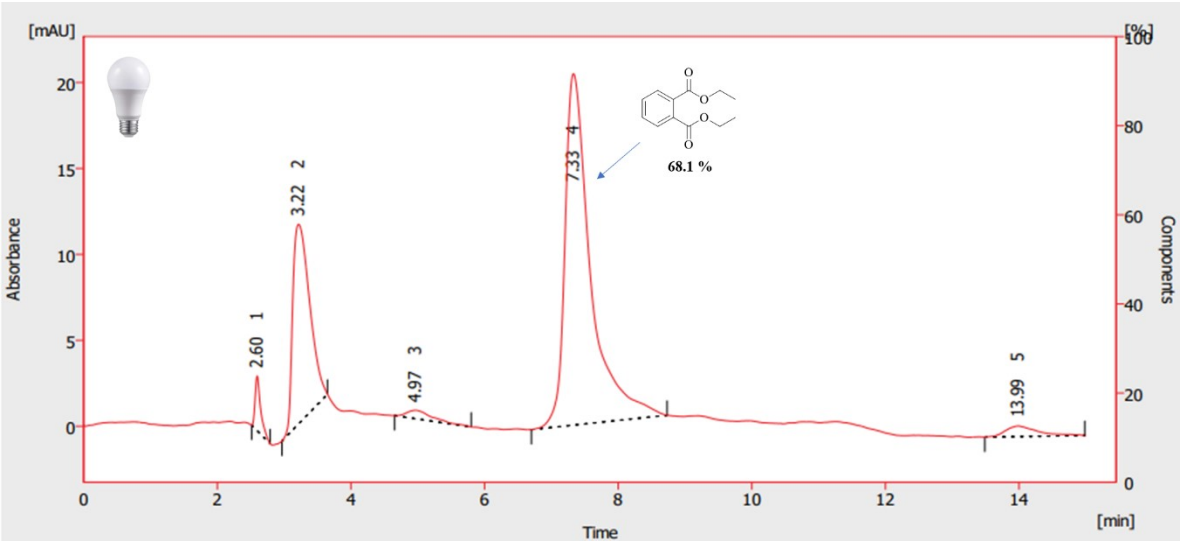


Figure S36. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under white LED after 180 min

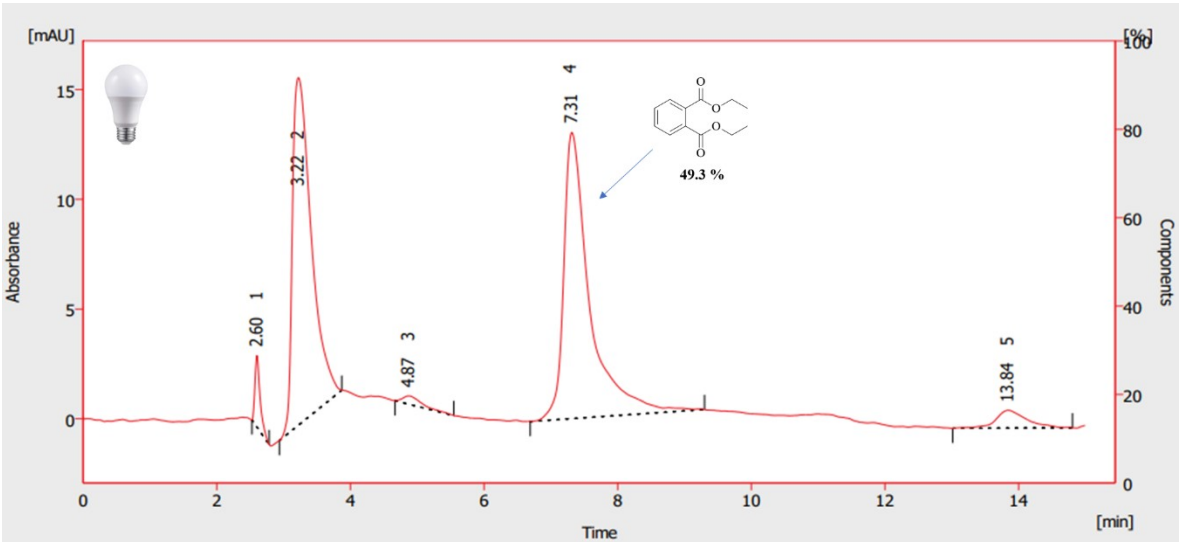


Figure S37. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under white LED after 240 min

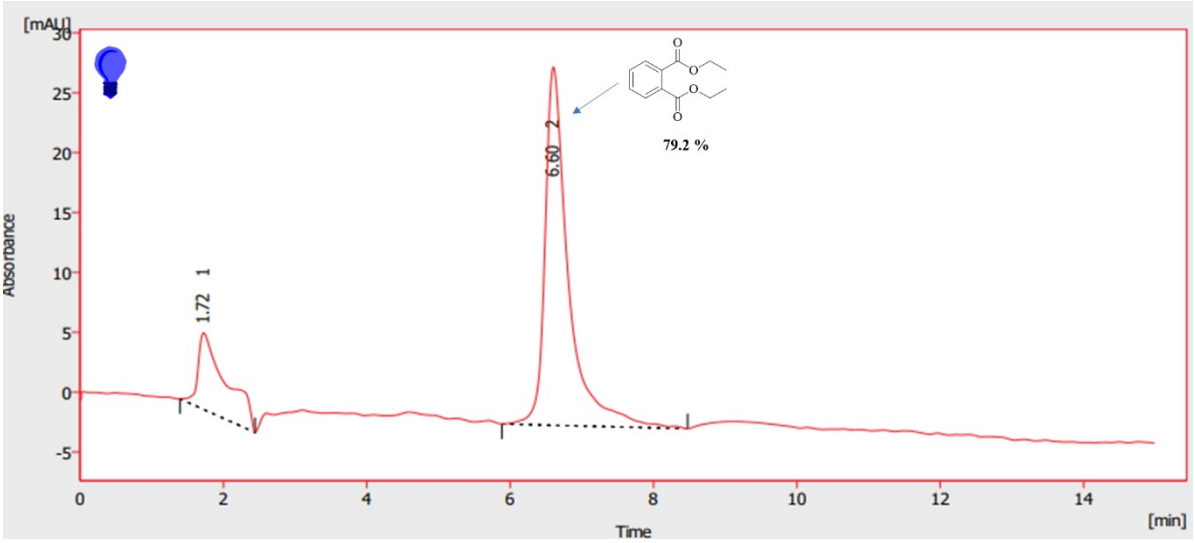


Figure S38. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under blue LED after 30 min in pH=5

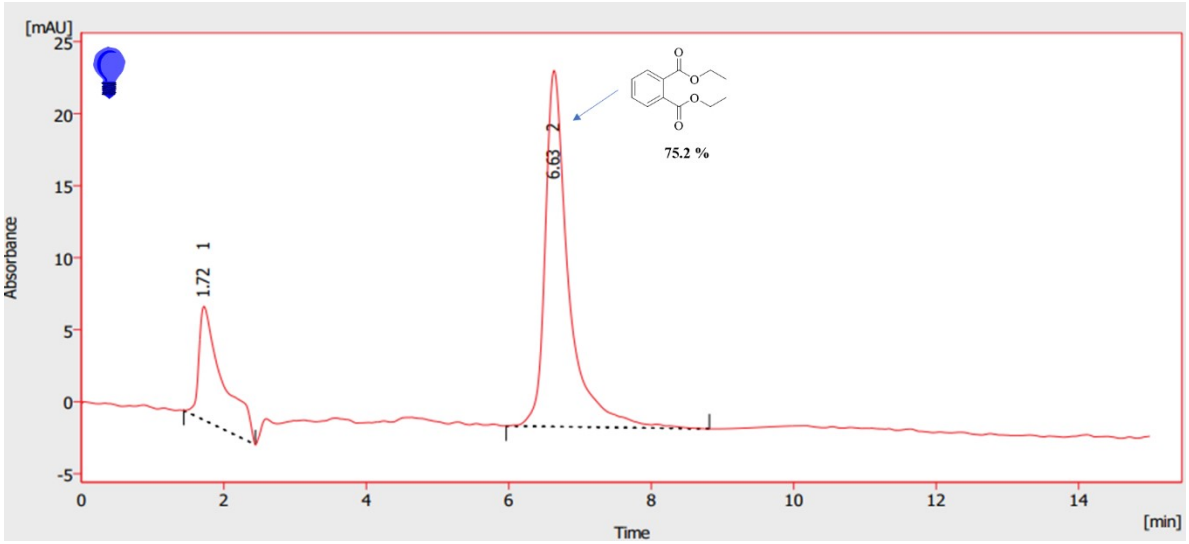


Figure S39. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under blue LED after 60 min in pH=5

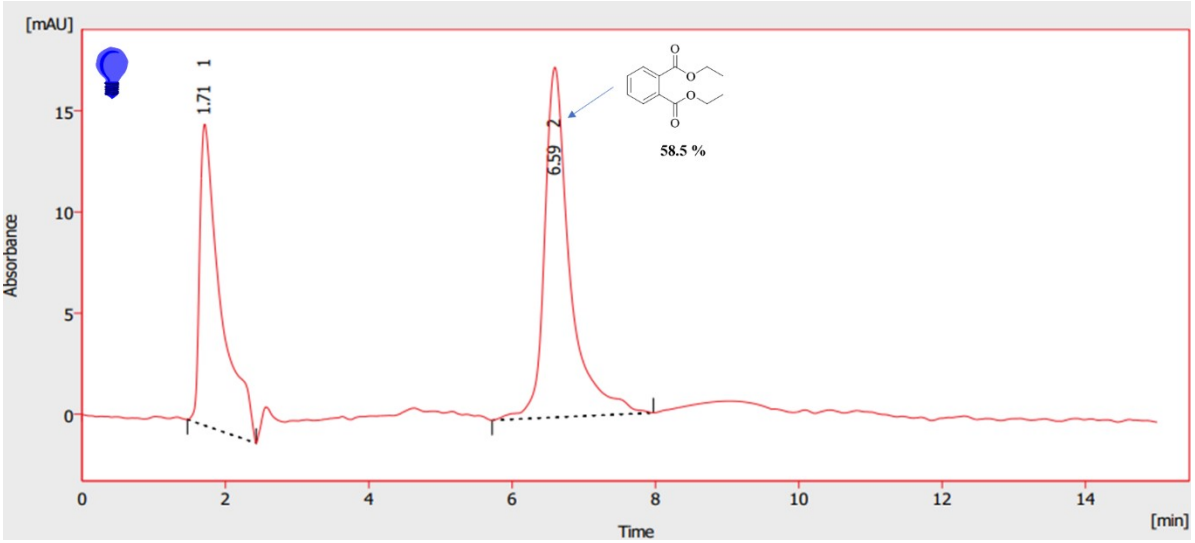


Figure S40. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under blue LED after 120 min in pH=5

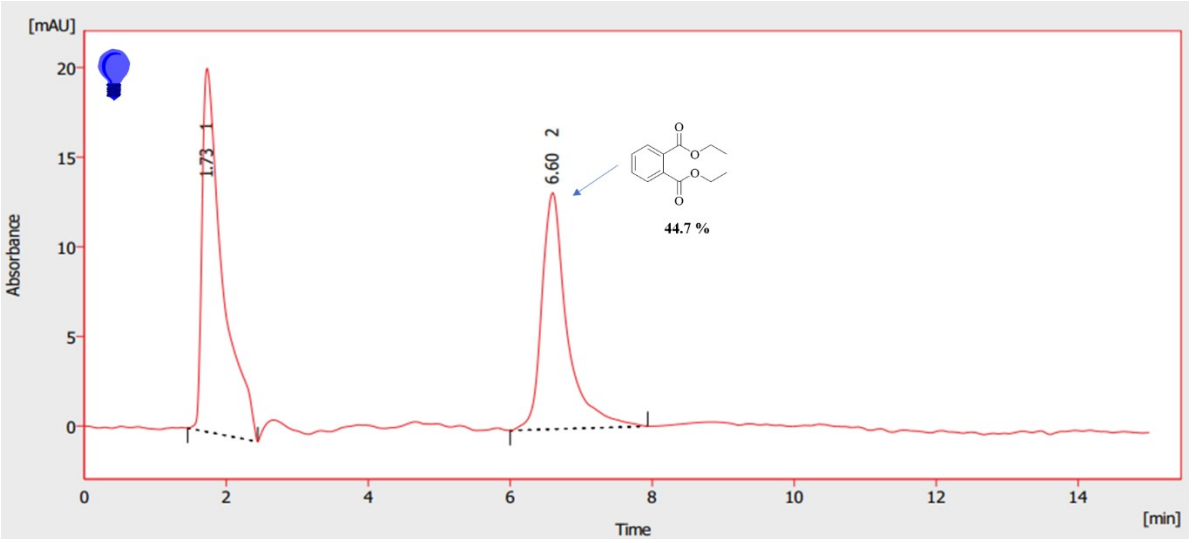


Figure S41. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under blue LED after 180 min in pH=5

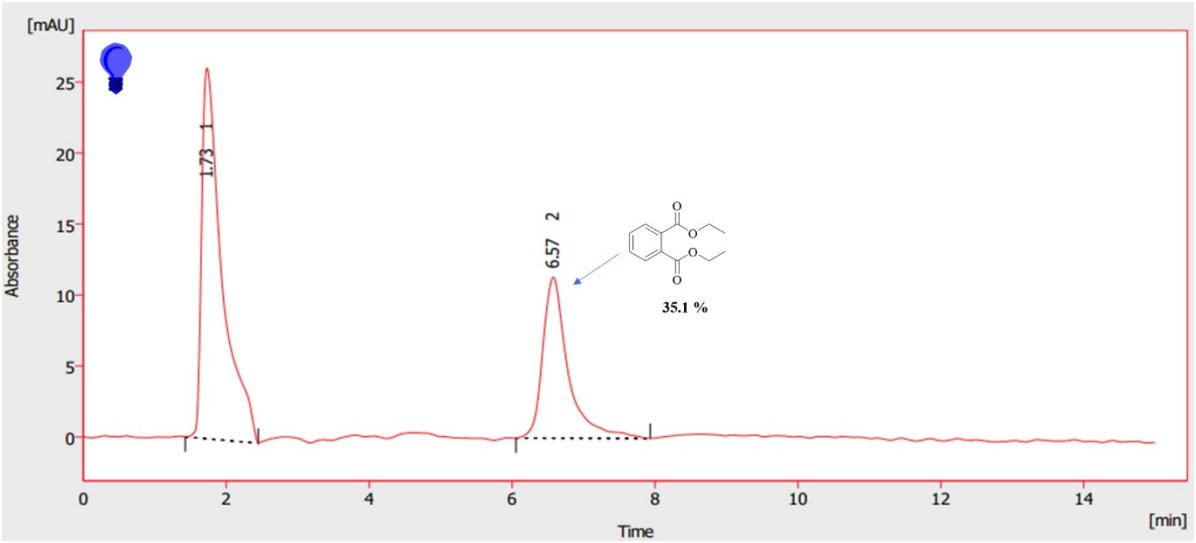


Figure S42. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under blue LED after 240 min in pH=5

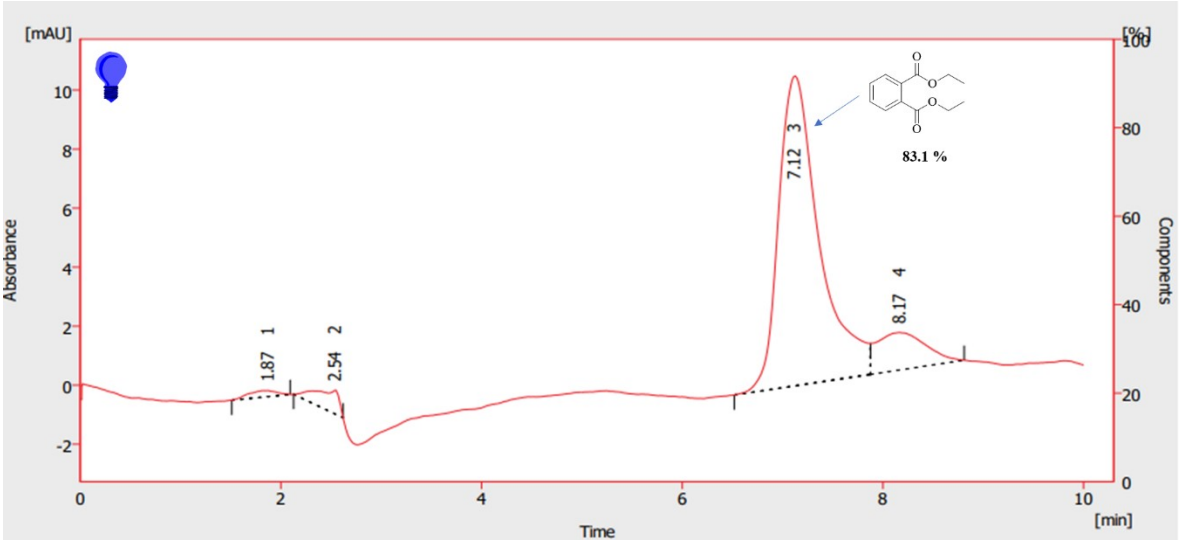


Figure S43. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under blue LED after 30 min in pH=9

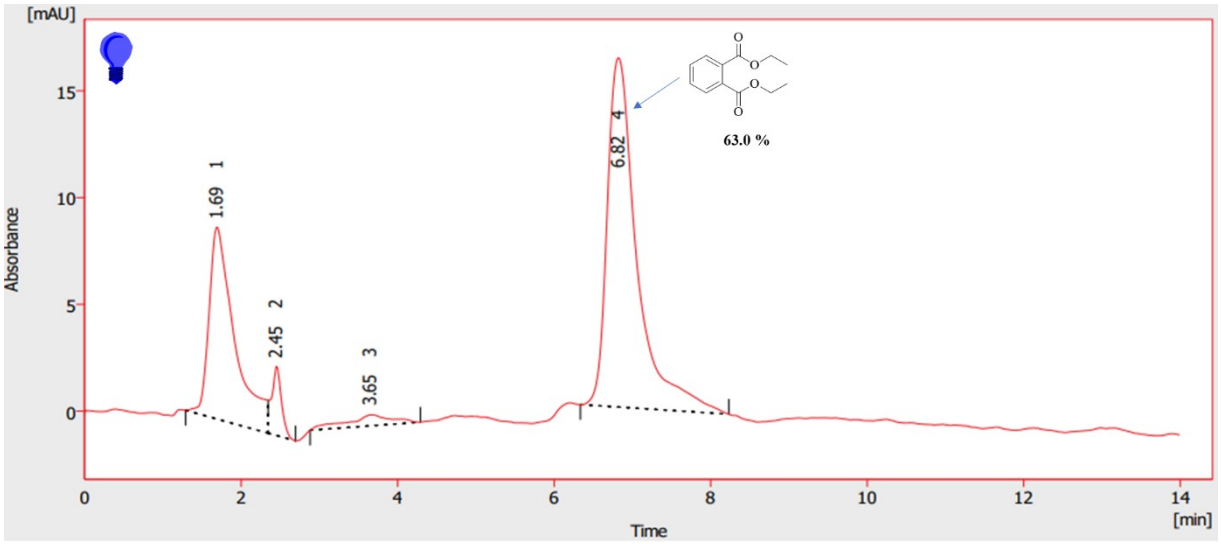


Figure S44. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under blue LED after 60 min in pH=9

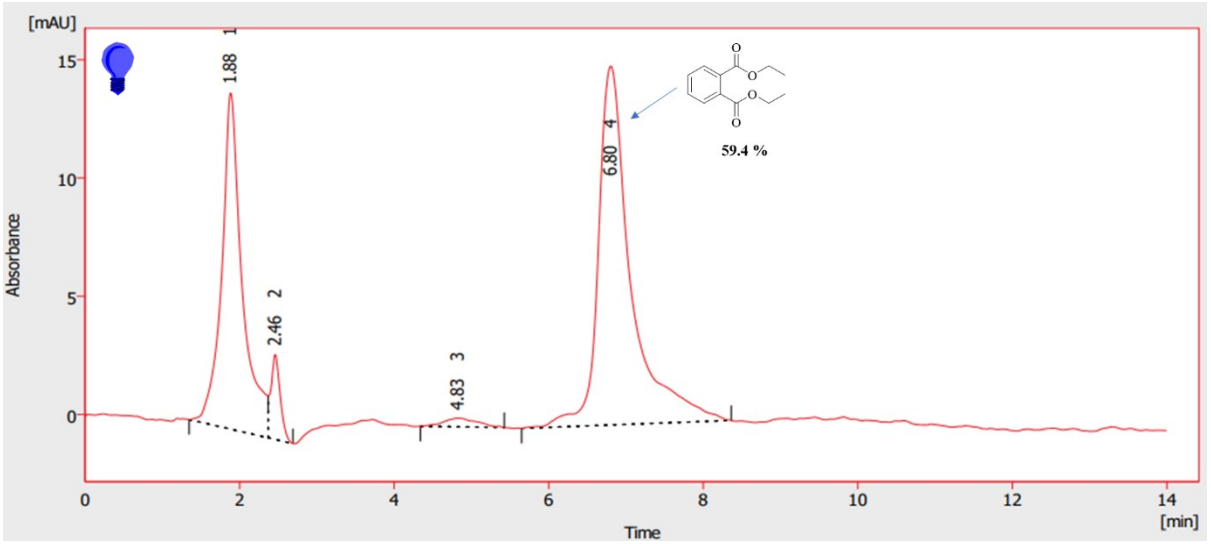


Figure S45. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under blue LED after 120 min in pH=9

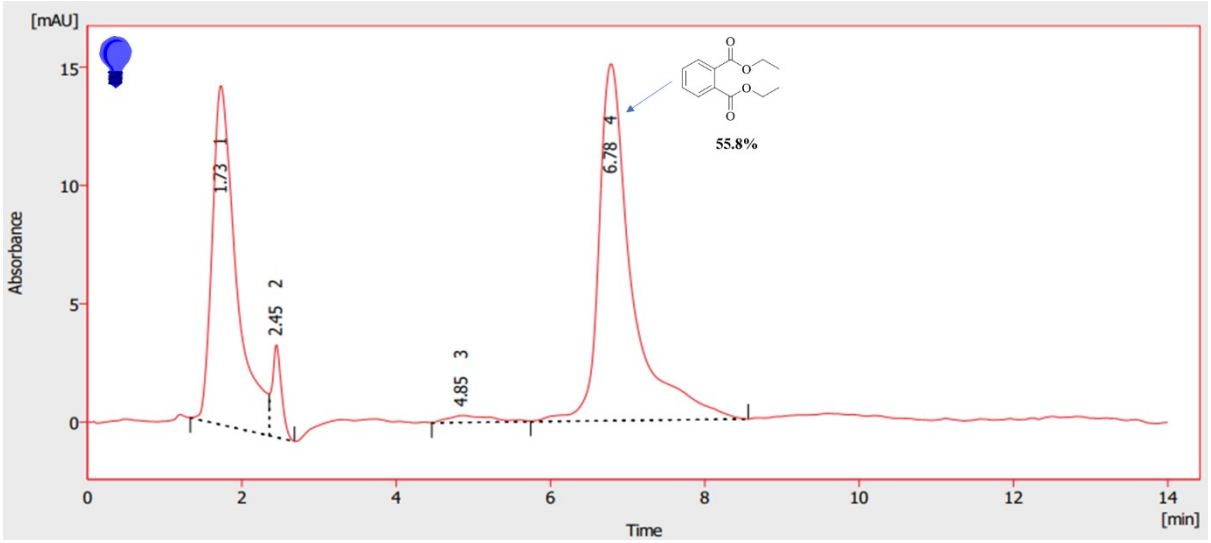


Figure S46. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under blue LED after 180 min in pH=9

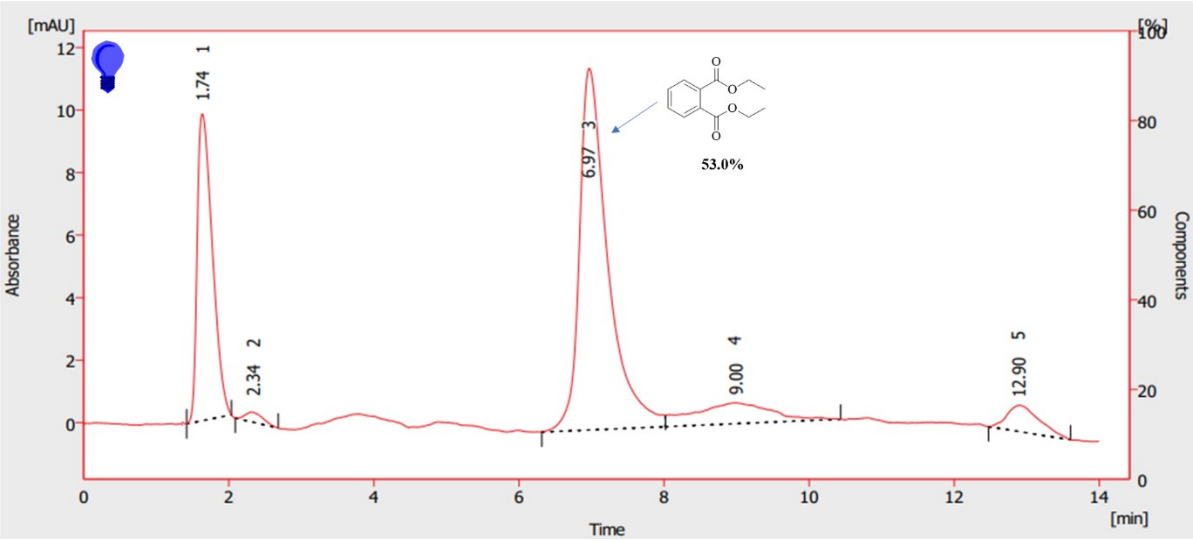


Figure S47. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under blue LED after 240 min in pH=9

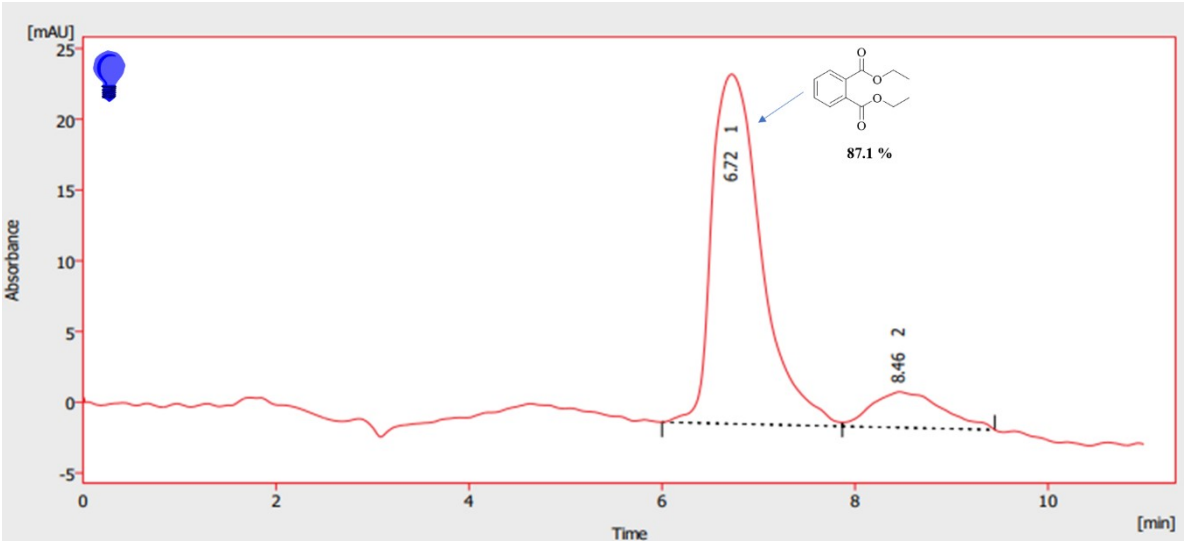


Figure S48. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2/TEMPO under blue LED after 240 min

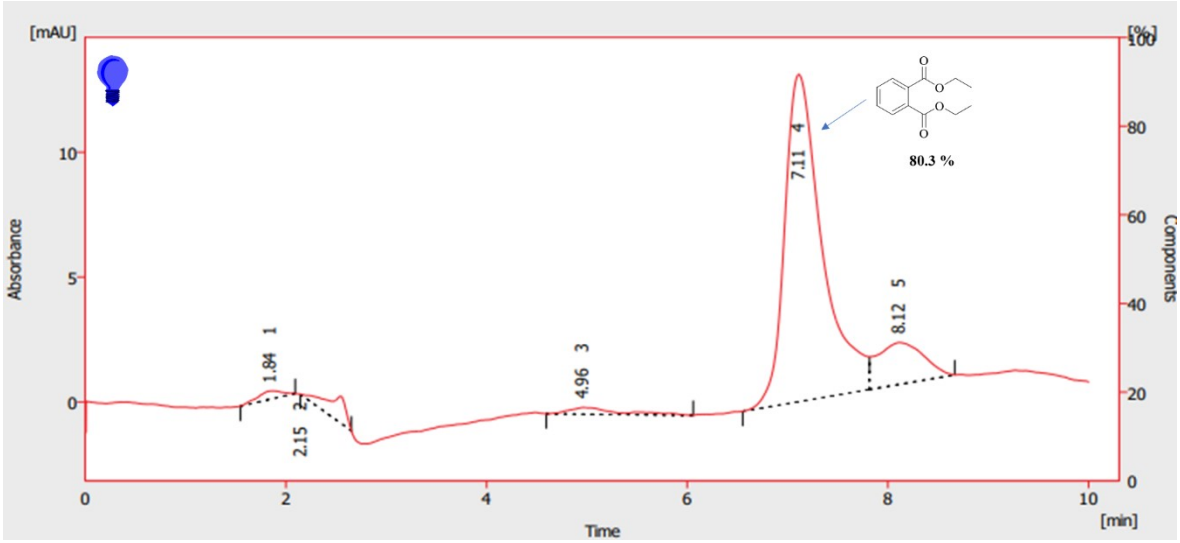


Figure S49. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2/TBA under blue LED after 240 min

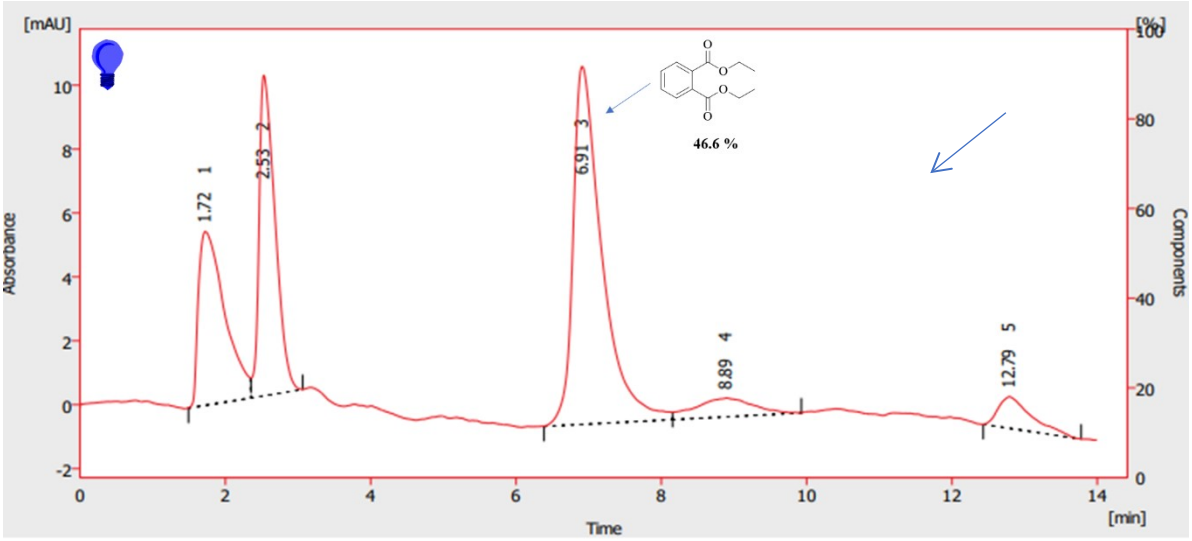


Figure S50. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under blue LED after 240 min cycle 1

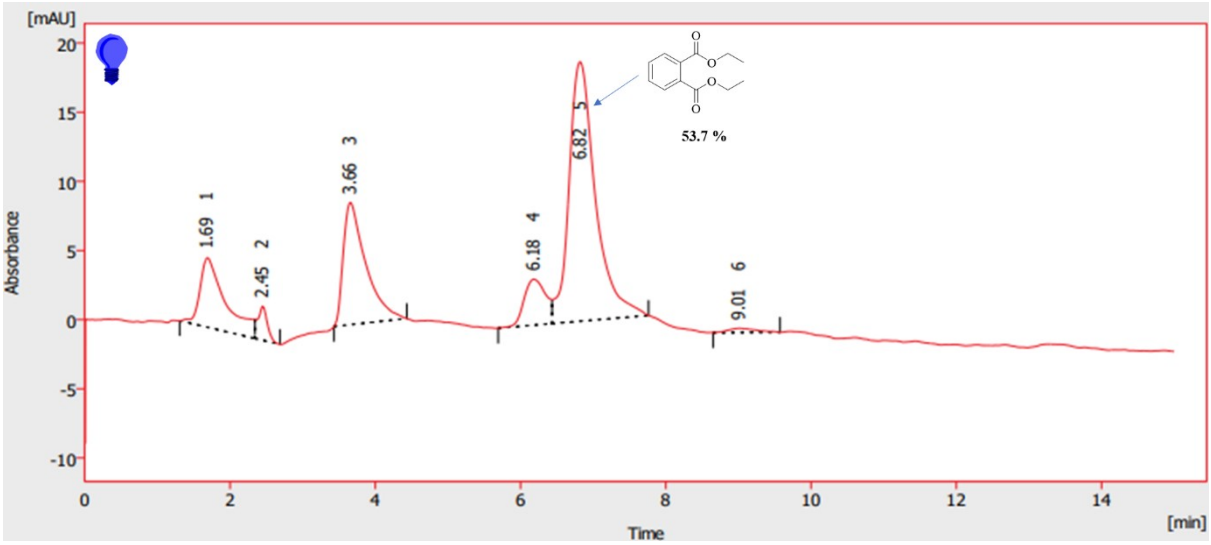


Figure S51. Photodegradation of DEP with Fc/g-C_3N_4/H_2O_2 under blue LED after 240 min cycle 2

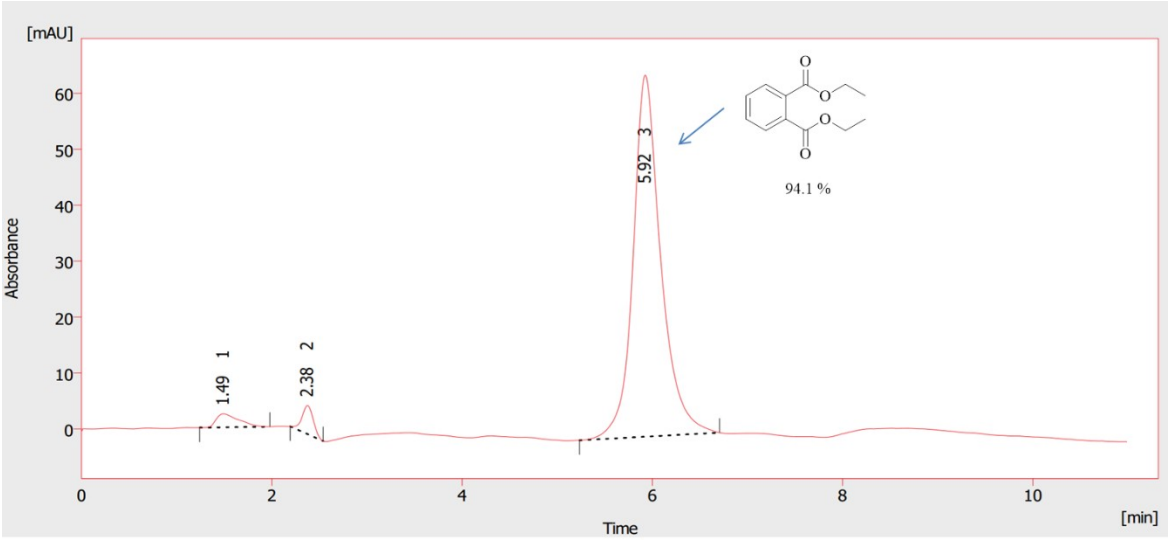


Figure S52. Photodegradation of DEP (30ppm) with Fc/g-C_3N_4/H_2O_2 under blue LED after 30 min

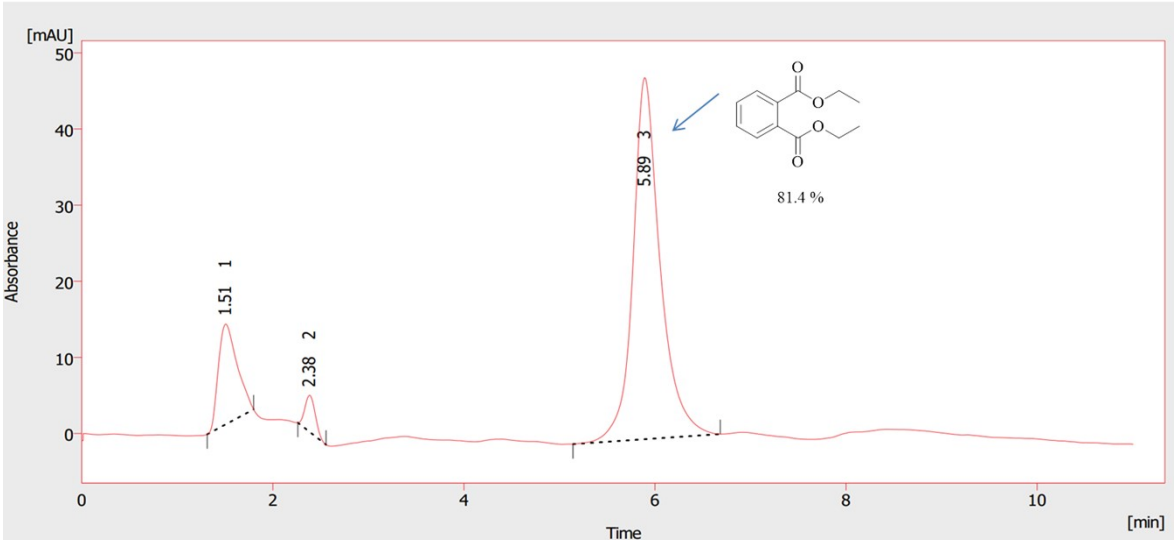


Figure S53. Photodegradation of DEP (30ppm) with Fc/g-C_3N_4/H_2O_2 under blue LED after 60 min

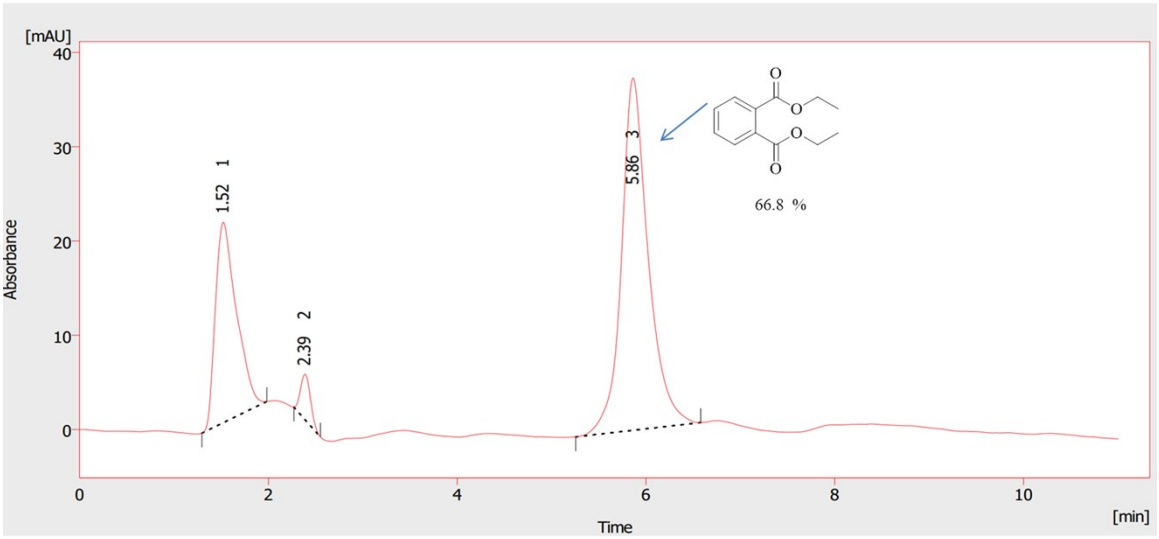


Figure S54. Photodegradation of DEP (30ppm) with Fc/g-C_3N_4/H_2O_2 under blue LED after 120 min

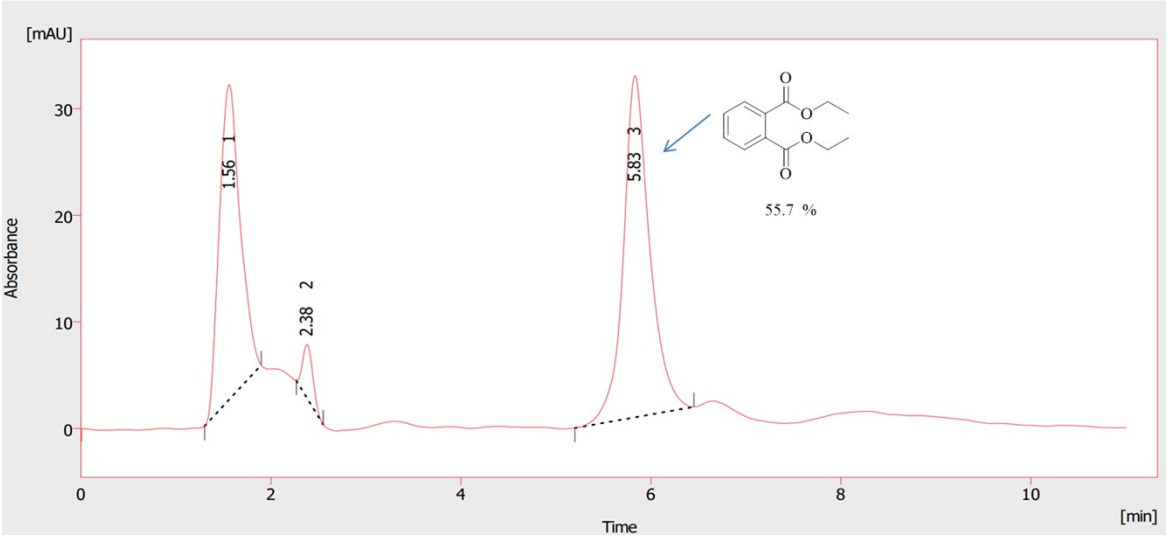


Figure S55. Photodegradation of DEP (30ppm) with Fc/g-C_3N_4/H_2O_2 under blue LED after 180 min

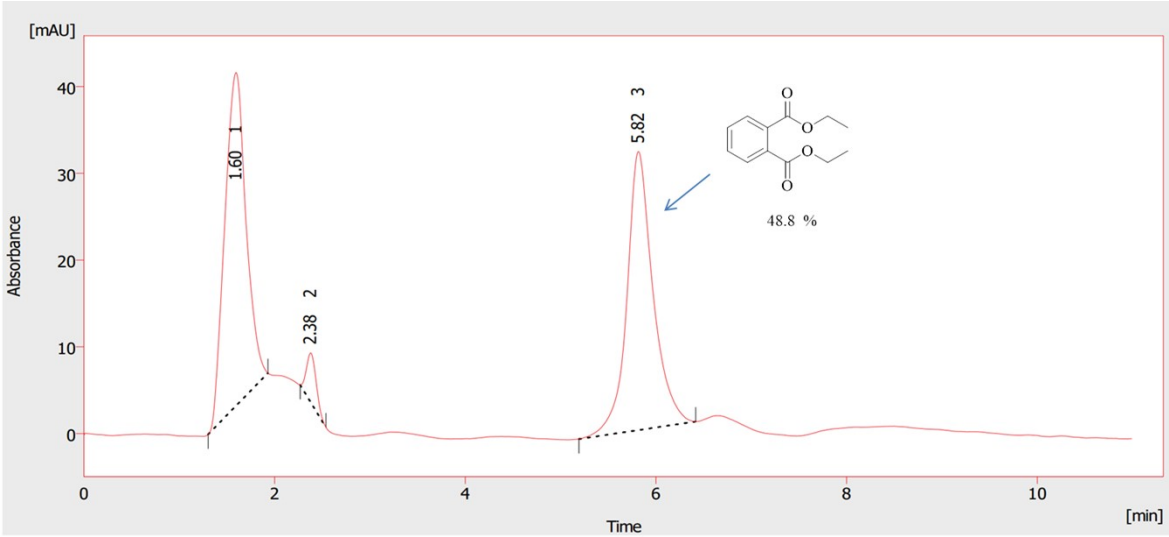


Figure S56. Photodegradation of DEP (30ppm) with Fc/g-C_3N_4/H_2O_2 under blue LED after 240 min

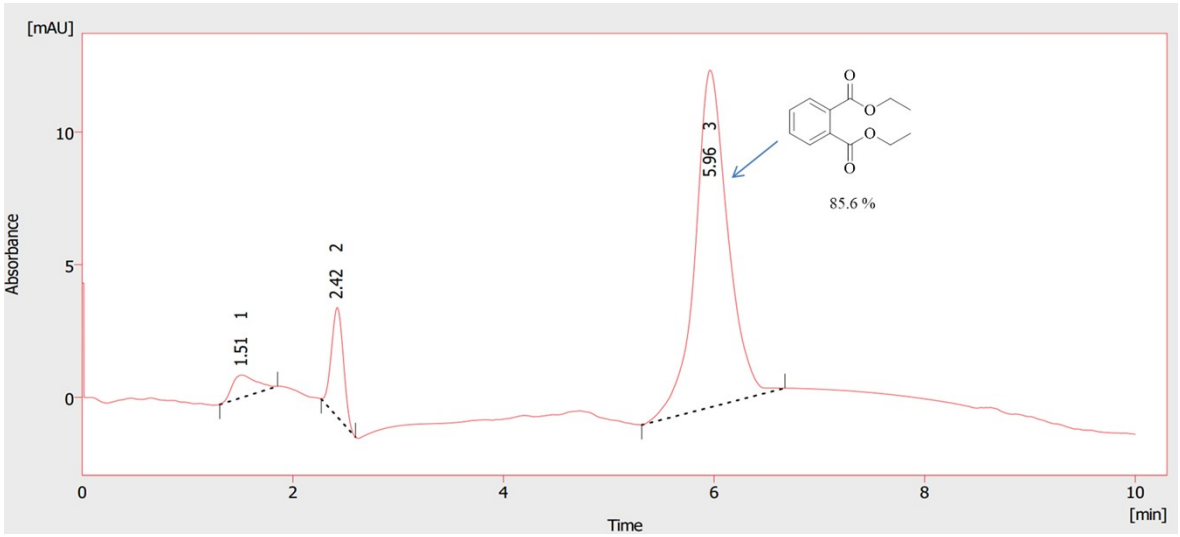


Figure S57. Photodegradation of DEP (10ppm) with Fc/g-C_3N_4/H_2O_2 under blue LED after 30 min

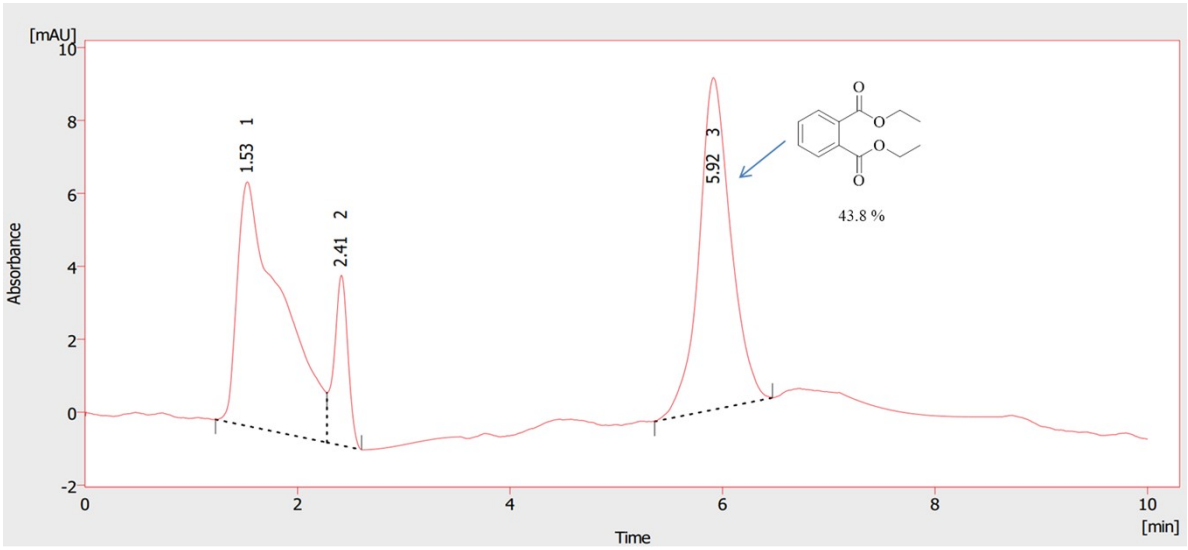


Figure S58. Photodegradation of DEP (10ppm) with Fc/g-C_3N_4/H_2O_2 under blue LED after 60 min

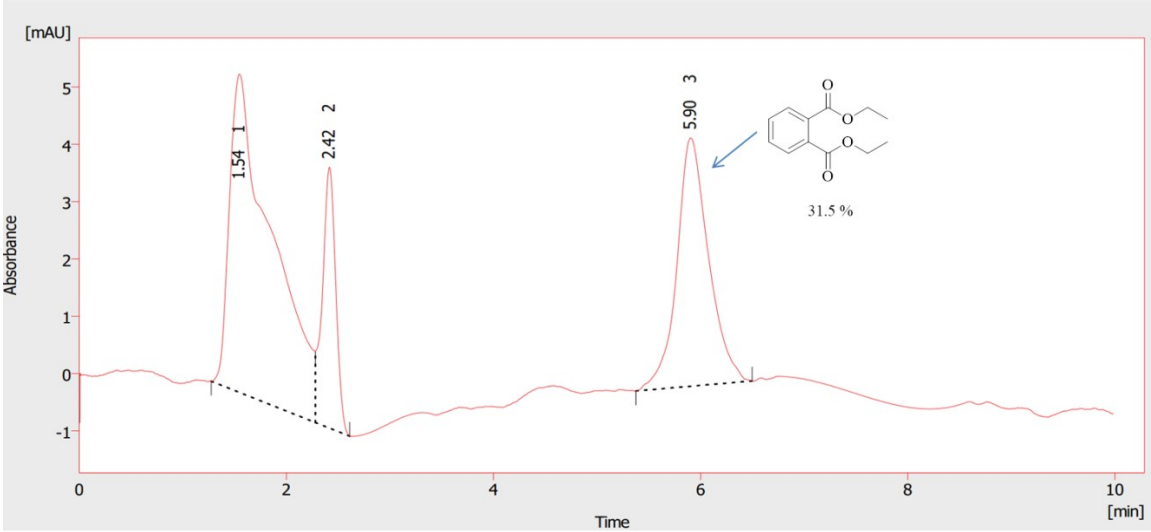


Figure S59. Photodegradation of DEP (10ppm) with Fc/g-C_3N_4/H_2O_2 under blue LED after 120 min

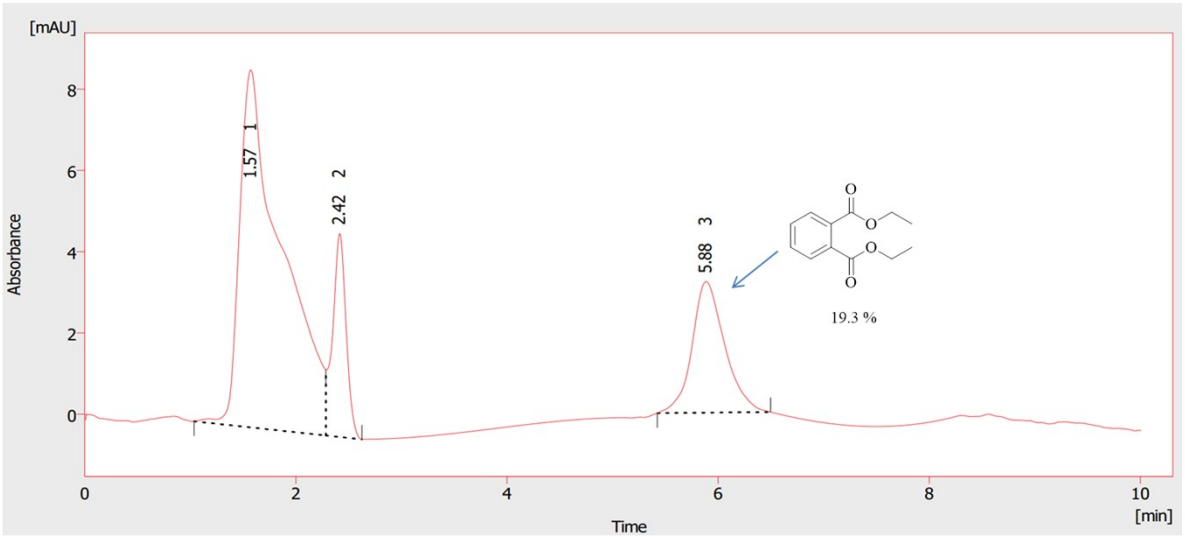


Figure S60. Photodegradation of DEP (10ppm) with Fc/g-C_3N_4/H_2O_2 under blue LED after 180 min

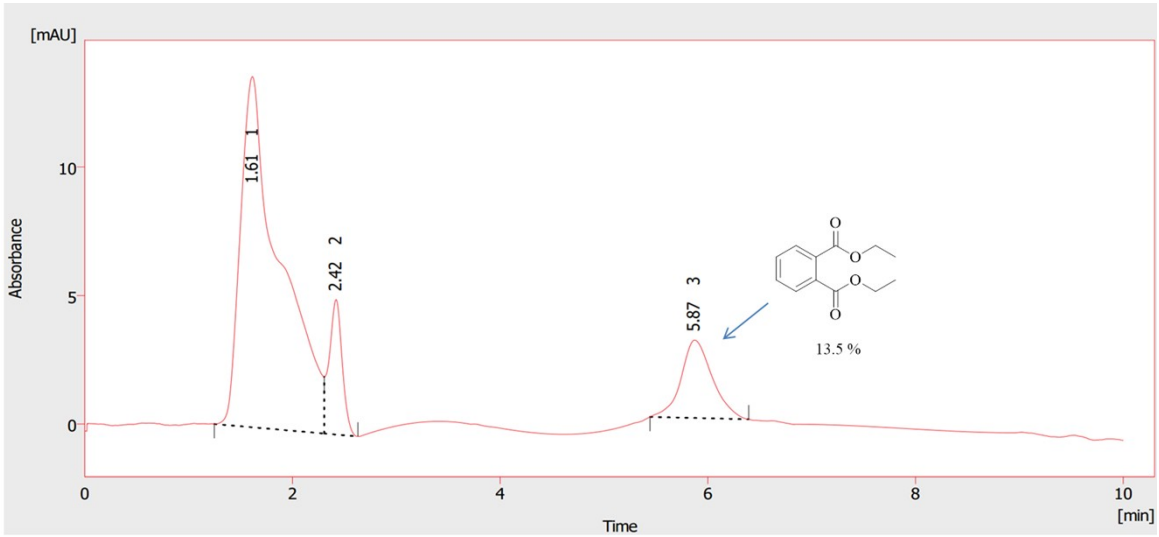
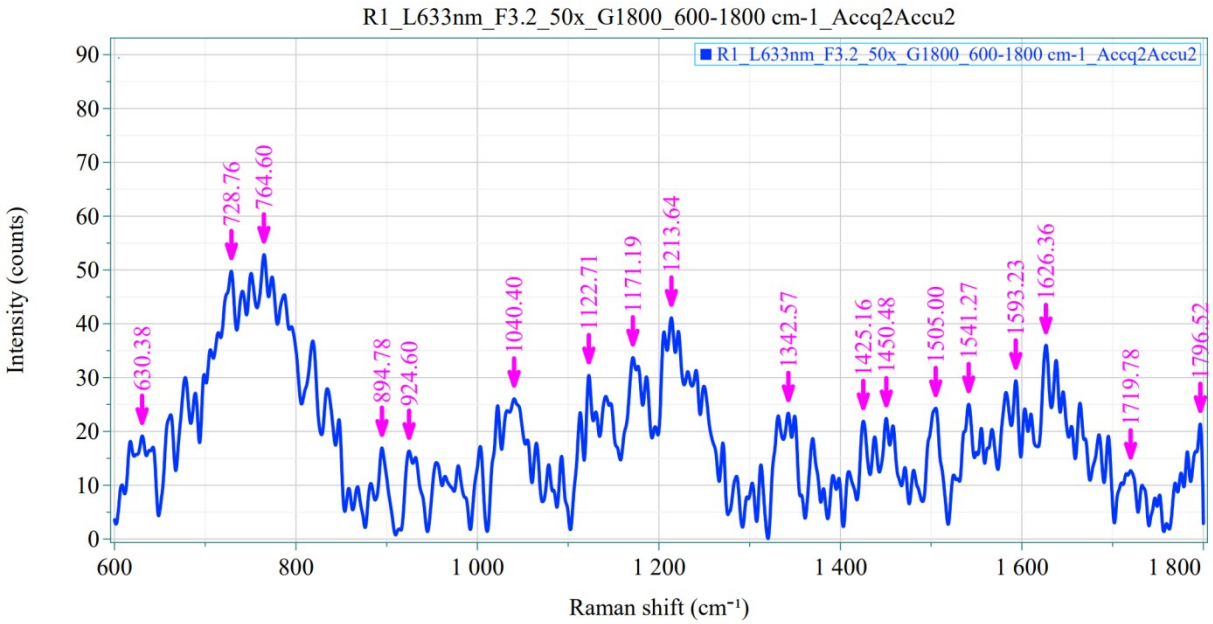


Figure S61. Photodegradation of DEP (10ppm) with Fc/g-C_3N_4/H_2O_2 under blue LED after 240 min



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ND Filter	3.2%	Objective	x50_VIS_LWD	ICS correction	On	Range (cm-¹)	

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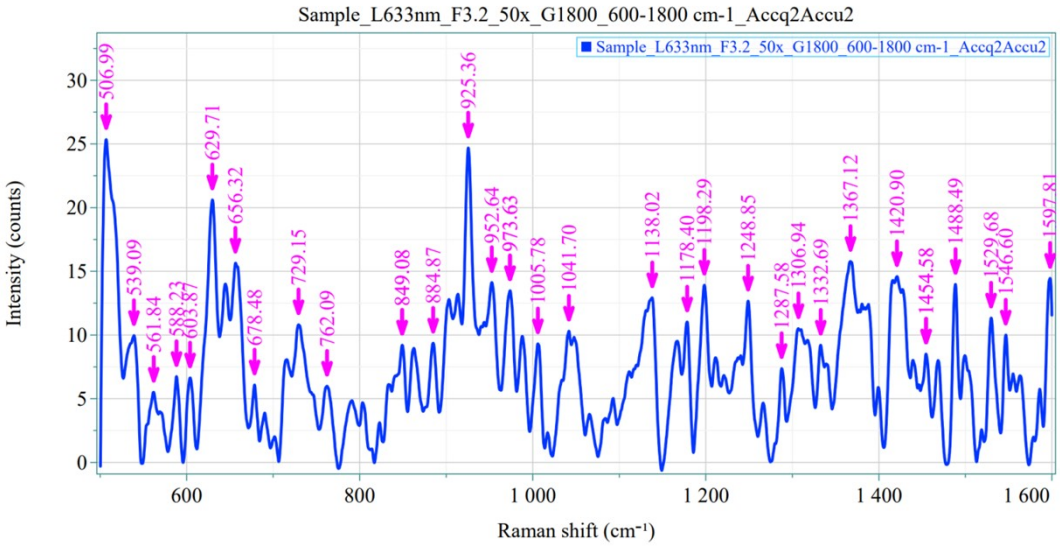
Raman spectroscopy of g-C_3N_4



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ND Filter	3.2%	Objective	x50_VIS_LWD	ICS correction	On	Range (cm-¹)	

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Raman spectroscopy of Fc/g-C_3N_4