**Supplementary information**

# Donor-acceptor organic nanostructure based on conjugated polymer for improving visible light driven photocatalytic activity towards degradation of dye in aqueous medium

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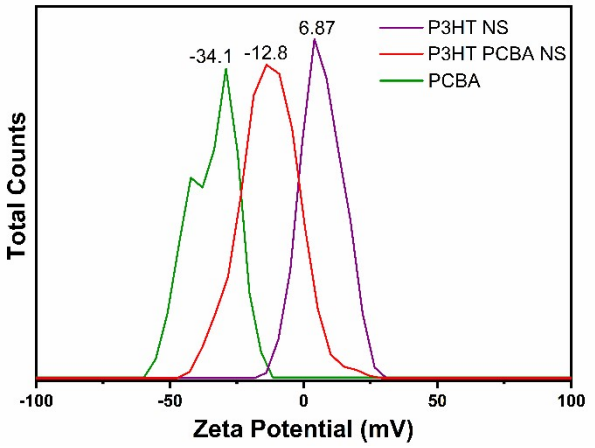


Figure S1 Zeta potential plot of P3HT NS, PCBA and P3HT-PCBA NS

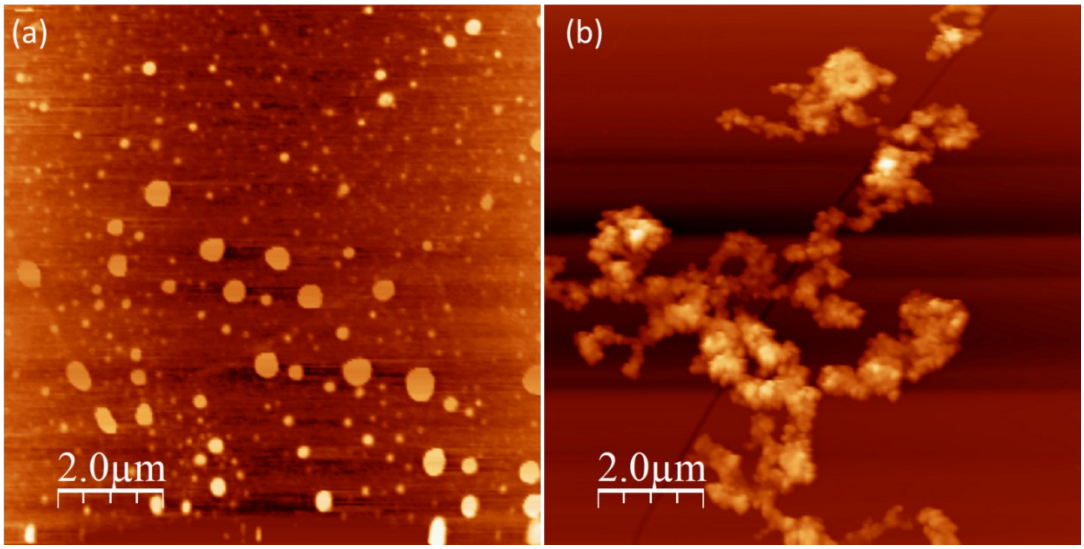


Figure S2 AFM image of (a) P3HT NS (b) P3HT-PCBA NS

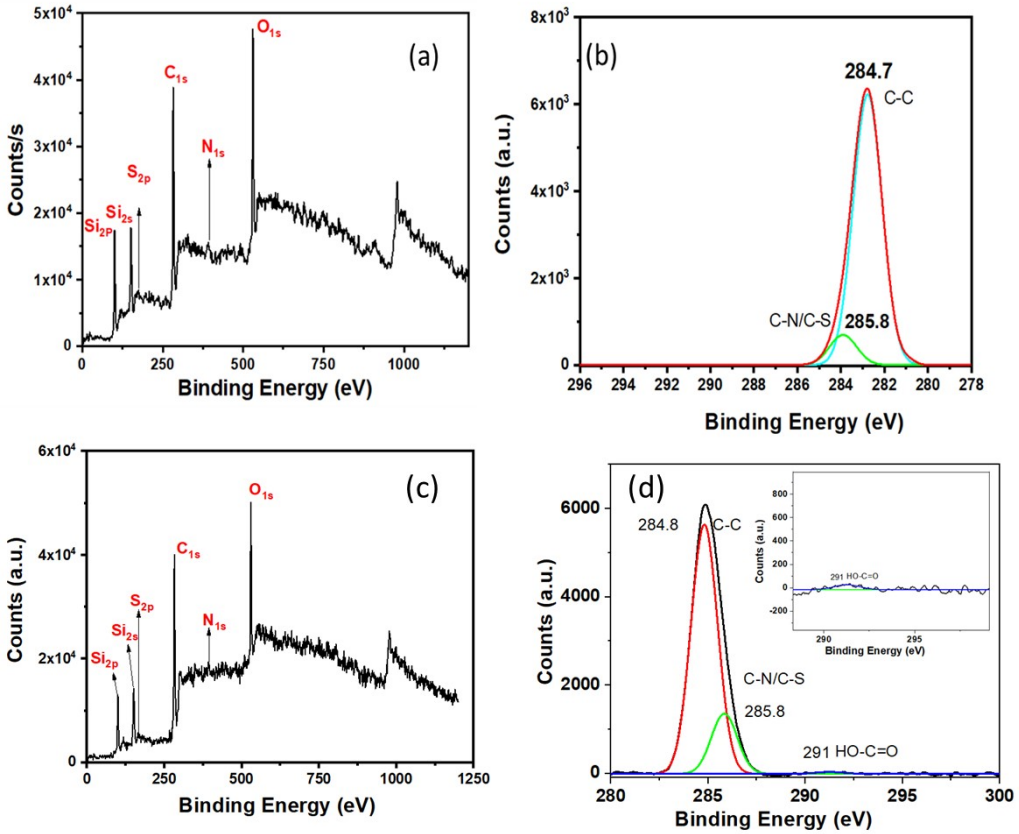


**Figure S3** Survey X-ray photoelectron spectroscopy (XPS) spectrum of P3HT-NS (a) and P3HT-PCBA NS (c). C1s spectra P3HT NS (b) and P3HT-PCBA NS (d)

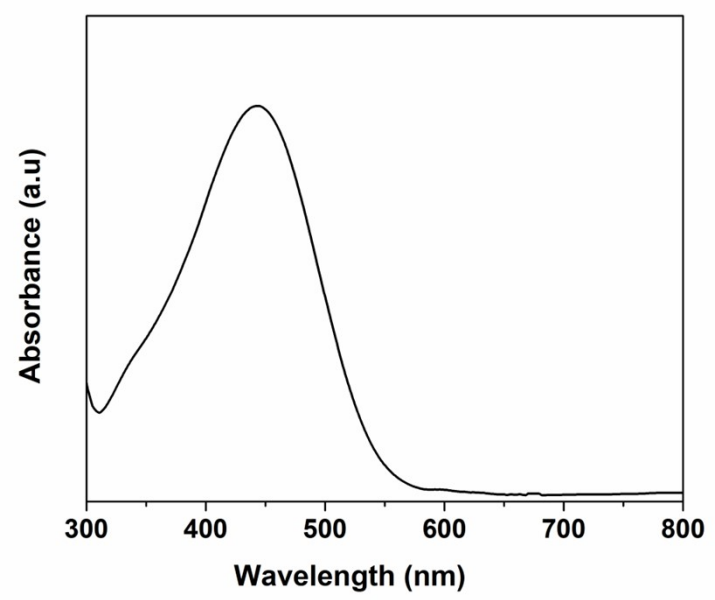


Figure S4 UV-vis absorption spectra of P3HT solution in THF.

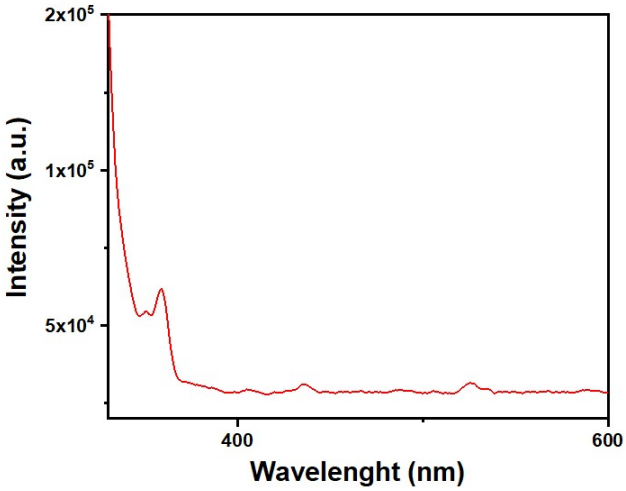


Figure S5 PL spectra of PCBA solution, excitation wavelength 320 nm.

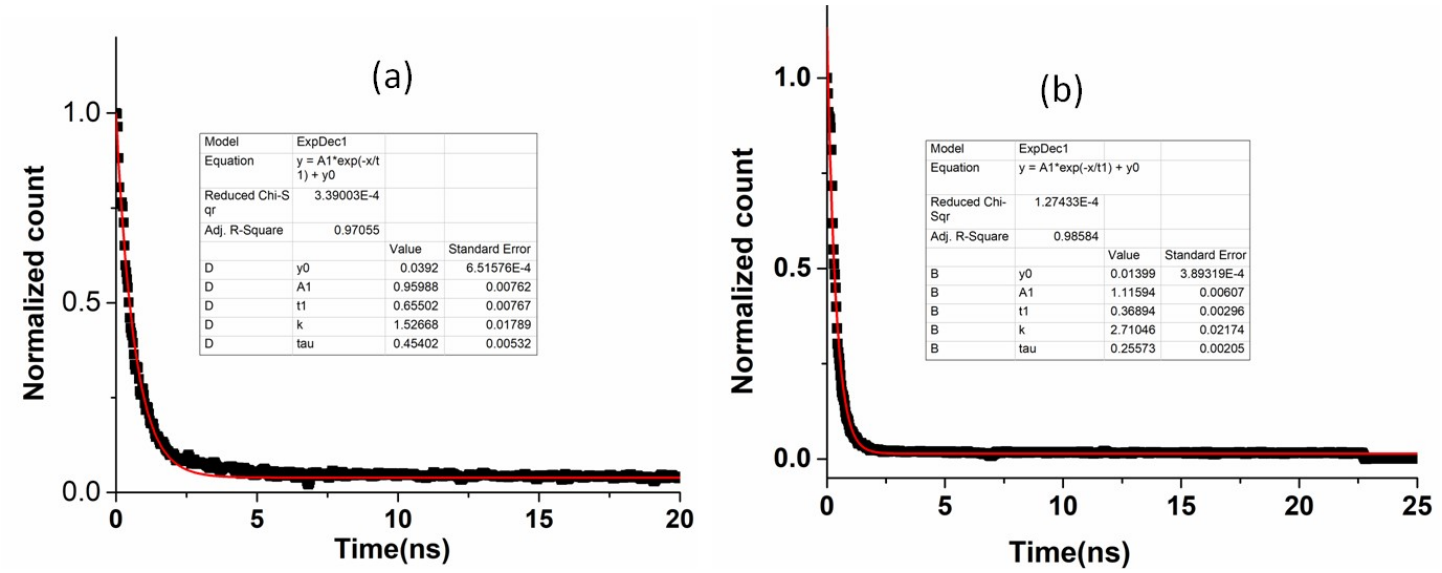


Figure S6 Time resolved emission decay curve fitting (a) P3HT NS (b) P3HT-PCBA NS with1:1 weight ratio of P3HT and PCBA.

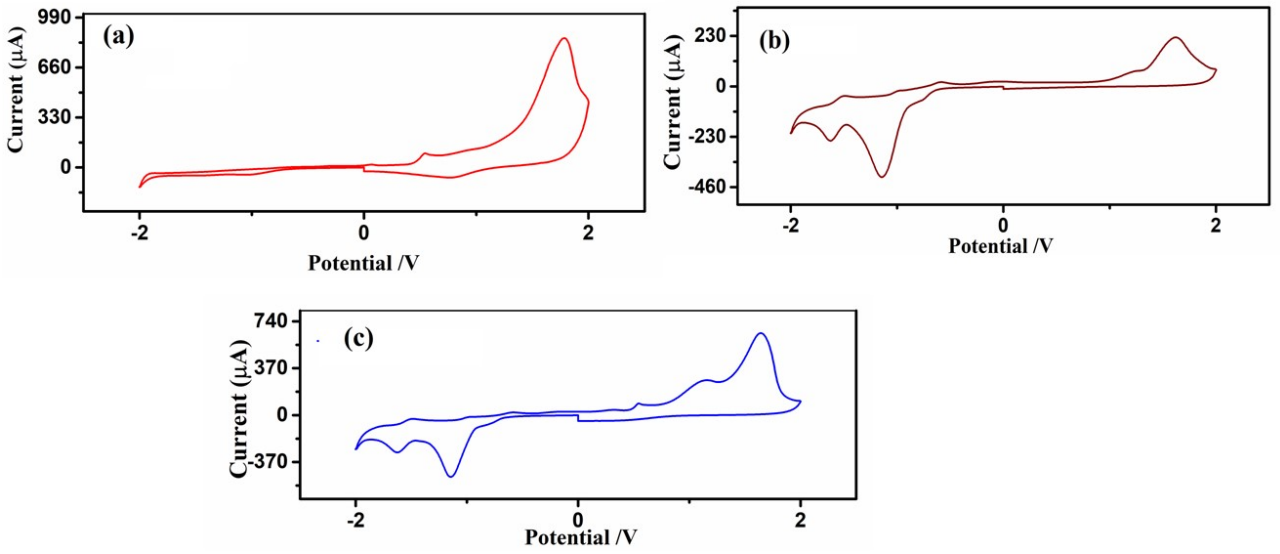

Figure S7 Cyclic voltammetry of (a) P3HT (b) PCBA (c) P3HT-PCBA hybrid material. The CV curves were recorded by depositing films of the material on glassy carbon electrodes. Platinum was used as the counter electrode, silver-silver chloride as a reference electrode, and 0.1 (M) tetrabutylammonium hexafluorophosphate ($Bu_4NPF_6$) in acetonitrile as the supporting electrolyte.

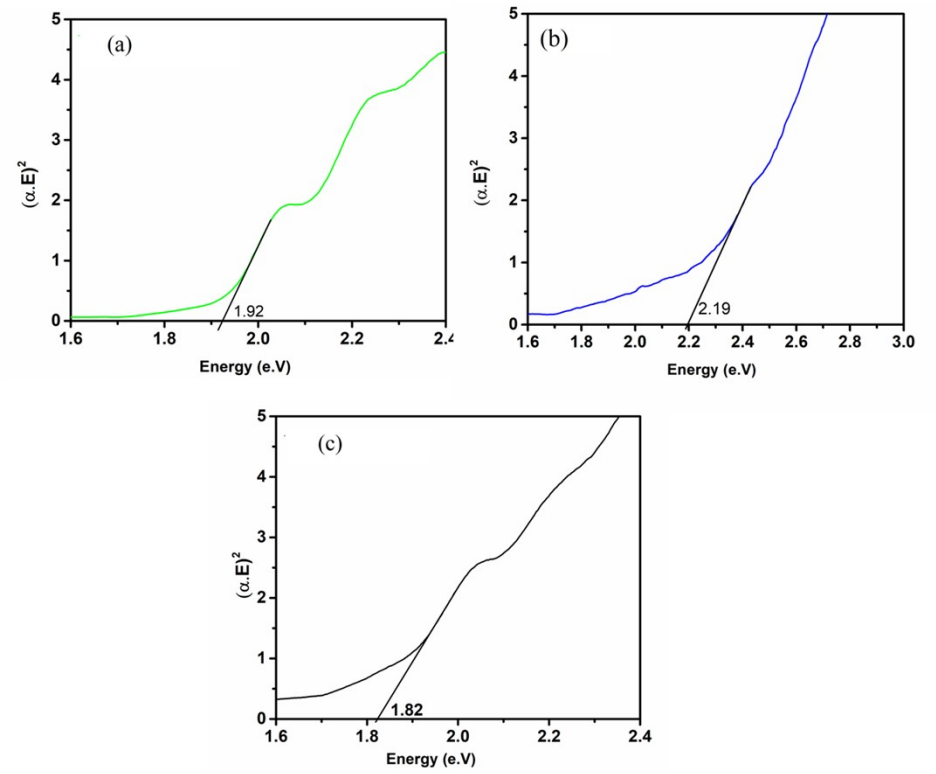


Figure S8 optical band gap determination of (a) P3HT NS (b) PCBA (c) P3HT-PCBA NS

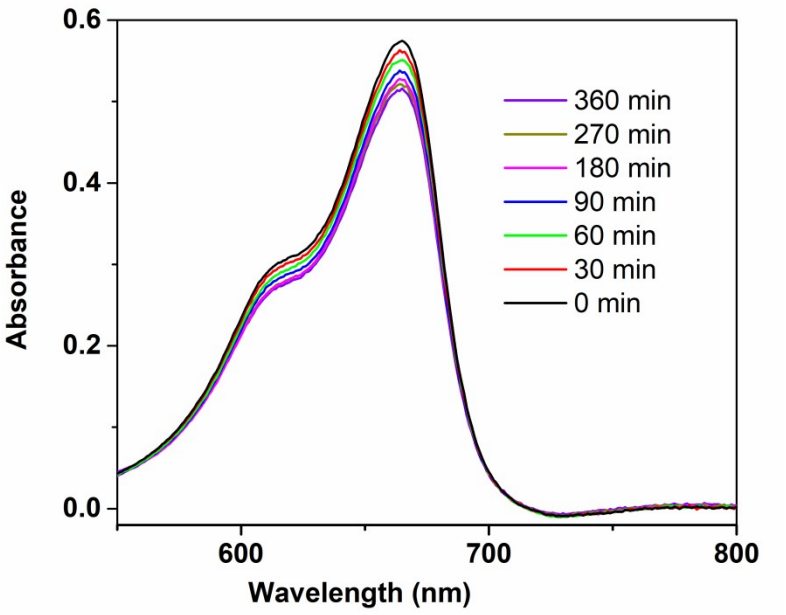

Figure S9 UV-vis spectra of MB solution after irradiation with light for different time. No external catalyst was added

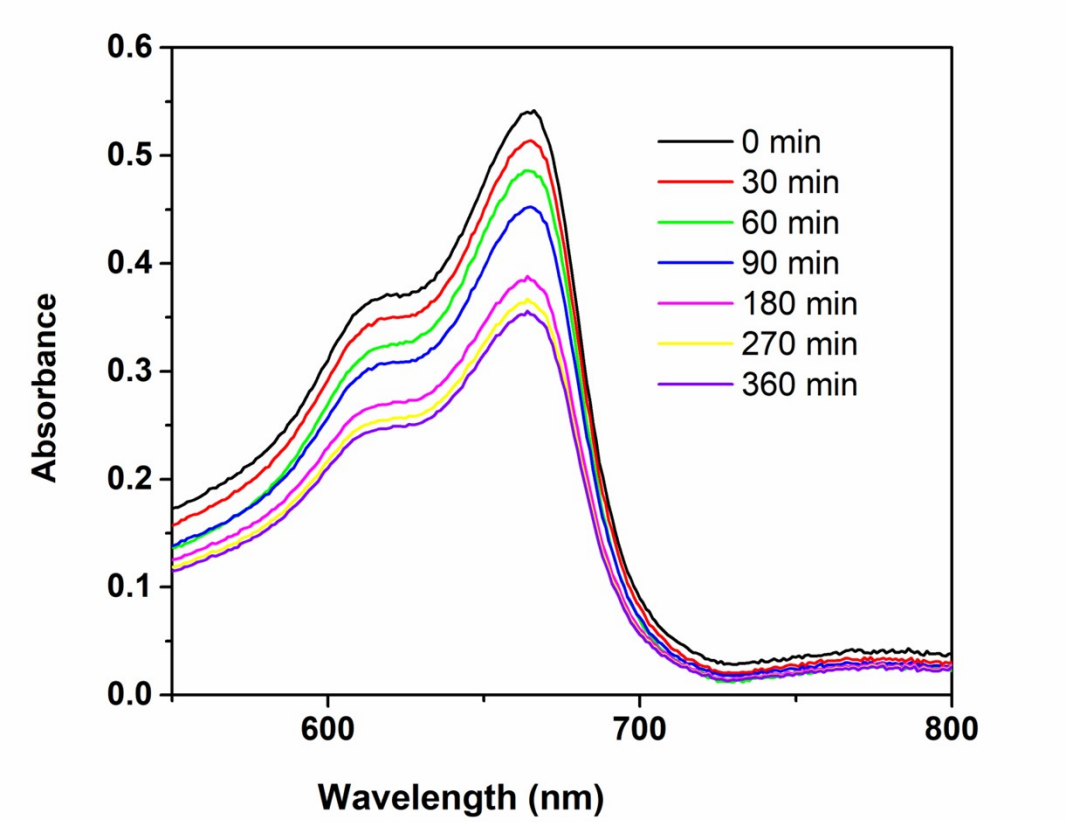


Figure S 10 UV-vis spectra of MB solution after irradiation with light for different time using P3HT NS as photocatalyst.

**Table S1.** Comparison of Photocatalytic activity of conjugated polymer or conjugated polymer composite material for degradation of dye under light irradiation.

| Catalyst (amount) | Dye (concentration) | Light used | Efficiency | Time | Rate constant | Whether used as dip photo catalysis or not | Reference |
|---|---|---|---|---|---|---|---|
| P3HT–Au hybrid Nanostructures (0.062 mg) | Methylene blue (0.064 mg) | Vis (300 W Xe lamp of a solar simulator) | 90.6% | 180 min | 1.29 $X10^{-2}$ ($min^{-1}$) | No | S1 |
| 9,9′-bifluorenylidene-based conjugated microporous/mesoporous polymers (10 mg) | Rhodamine B (3.75 mg) | Vis [xenon lamp light source (300 W)] | 92% | 90 min | NA | No | S2 |
| poly(1,3,4-oxadiazole)s | Methylene blue | UV | ~100% | 180 min | NA | No | S3 |
| P3HT Colloids | Methylene blue | UV | 96.6 % | >72 hours | NA | NO | S4 |
| Poly(3-hexylthiophene) Nanostructures | Phenol | UV & Vis | 87% (UV light) 16% (Vis light) | 240 min | NA | By depositing polymer on quartz glass up to 4 cycles | S5 |
| poly(diphenylbutadiyne) nanostructures | Methyl orange | Vis light | 75% | 240 min | NA | No | S6 |
| P3HT-$TiO_2$ | Methyl orange | Vis light | 88.5% | 10 hours | NA | NO | S7 |

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|---|---|---|---|---|---|---|---|
| PEDOT nanostructures | Phenol<br><br>Methyl orange | Vis | 100% (phenol)<br><br>100 %(MO) | 240 min<br><br>180 min | NA | No | S8 |
| P3HT-ZnO composite | Rhodamine B (RhB) | Vis | 100% | 80 min | 0.03127 $min^{-1}$ | No | S9 |
| P3HT-PCBM (5 mg) | Rhodamine B (RhB) (2ppm) | Vis [186 $w/m^2$ or Mercury xenon lamp (200W)] | 95.1% | 120 min | 0.0219 | Yes (by depositing thin film on glass slide), up to 3 cycles | S10 |
| Perylene diimide based porous conjugated polymer | Methylene blue | UV light( 150 W Xe light-source) | ≈75 % | 200 min | N A | NO | S11 |
| triazine-based covalent organic polymer (20 mg) | Methyl orange, Methylene blue & RhB | Visible light( LED (10 W) or natural light irradiation) | 67% MO, 78% RhB and 57% MB degradation under visible light in presence of f 30% $H_2O_2$ | MO (12 hours)<br><br>RhB(150 min)<br><br>MB (100 min) | MO( 0.00151 $min^{-1}$)<br><br>RhB( 0.00871 $min^{-1}$)<br><br>MB( 0.00610 $min^{-1}$) at 30 $^0C$ | NO | S12 |
| P3HT-phenyl C-61 butyric Acid hybrid nanostructure ( 0.5 mg) | Methylene blue (0.256 mg) | 20 Watt white LED bulb | 87.5% | 270 min | 7.82 $X10^{-3}$ $min^{-1}$ | Yes, flexible dip catalytic membrane up to $4^{th}$ cycle | This work |

**Table S2** Effects of different scavengers on the photocatalytic efficiency of phenol degradation.

| ***Photocatalyst*** | ***Scavenger*** | ***Trapped species*** | ***Degradation (%)*** |
|---|---|---|---|
| P3HT-PCBA NS | No scavenger | / | 82.5% |
| | benzoquinone (BQ) | $\cdot O_2^-$ | 80% |
| | isopropanol (IPA) | ·OH | 81% |
| | Triethanolamine (TEOA) | $h^+$ | 75% |
| | $AgNO_3$ | e | 37% |

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