

Supplementary Table S1. Characterization of photocatalysts employed in the photodegradation of Congo Red

Reference/ Material	Characterization
[1] TiO ₂ /reduced graphene oxide sheets (rGO/TiO ₂)	The rGO/TiO ₂ nanocomposite morphology was analyzed using transmission electron microscopy (TEM), which showed that TiO ₂ nanoparticles were dispersed on the surface of the rGO sheets. The X-ray photoelectron spectrum (XPS) analysis revealed that the bonding of TiO ₂ with rGO occurred through the formation of Ti-C and Ti-O-C bonds. The diffuse reflectance spectroscopy (DRS) showed a decrease in band gap upon an increase in rGO concentration. Also, confirmation was obtained regarding the reduction of recombination carriers through the photoluminescence (PL) spectrum. The results indicated that the prepared nanocomposite had many oxygen vacancies.
[2] TiO ₂ -doped cobalt ferrite nanoparticles	The powder XRD pattern proved that the obtained crystallite size of CoFe ₂ O ₄ is 44 nm and TiO ₂ doped CoFe ₂ O ₄ is 25 nm. Also, the crystalline size was much lower for TiO ₂ -doped CoFe ₂ O ₄ when compared to the CoFe ₂ O ₄ due to TiO ₂ doping. Furthermore, the SEM images of TiO ₂ -doped CoFe ₂ O ₄ indicate that the smaller particles were dispersed with a high aggregation due to the interfacial surface tension between the titania and cobalt ferrite particles. DRS spectra proved the measured bandgap of the corresponding CoFe ₂ O ₄ and TiO ₂ -doped CoFe ₂ O ₄ nanostructures are 3.01 and 2.88 eV. The microstructure and the dimension of the synthesized CoFe ₂ O ₄ and TiO ₂ -doped CoFe ₂ O ₄ spinel ferrites nanostructures were observed by a high-resolution transmission electron microscope (HR-TEM).
[3] Fe-doped TiO ₂ -activated carbon (AC) nanocomposite	The XRD peaks confirmed that the samples had an anatase crystalline form of TiO ₂ . The peaks related to Fe ions are not found in the XRD pattern of the nanocomposite. This agreed with the fact that Fe ions were incorporated into the crystal lattice of titania due to the similar radius of Ti ⁴⁺ (0.068nm) and Fe ³⁺ (0.064nm). SEM image analysis of FDT/AC nanocomposite concluded that white spherical particles of TiO ₂ with different sizes were irregularly agglomerated on the surface of the activated carbon, and there were Fe ions accumulated or attached to the surface of the TiO ₂ . The presence of Fe ions on the surface of the AC was expected to increase the absorption of light in the visible light region, thus enhancing the photocatalytic activity. The purity and elemental composition of the FDT/PAC nanocomposite were analyzed by Energy-Dispersive X-ray spectroscopy analysis (EDX) and revealed that the FDT/PAC nanocomposite has a Fe content of 29.27%, Ti of 28.69%, C of 2.52%, and O of 28.22%, which confirmed the equal distribution of Fe, Ti, and O over the C surface. The Fourier Transform Infrared Spectroscopy (FTIR) spectra analysis of the nanocomposite suggested that the TiO ₂ nanoparticles were attached chemically to the C surface. Hence, Ti cannot be easily separated from the C surface. According to UV-Vis DRS analysis, the presence of Fe ions in the composite decreases the electron-hole recombination by increasing the

	lifetime of the charge carrier, which is expected to improve the photocatalytic activity.
[4] TiO ₂ co-doped with Fe, Co, and S	XRD patterns of TiO ₂ co-doped with Fe, S, and Co by varying concentrations of Co. The average crystallite sizes of TiO ₂ /Fe/Co/S nanoparticles (NPs) were calculated using the Debye-Scherrer equation, and results indicate that co-doping with Co and Fe decreased the size of the crystal of TiO ₂ . SEM analysis was used to study the surface morphology and size of pure and doped TiO ₂ photocatalysts. It reflected that particles of TiO ₂ are spherical and co-doping with Fe and Co did not affect the surface morphology, indicating successful incorporation of dopants into the lattice of TiO ₂ . The FTIR data showed that transmittance decreased gradually, and absorbance increased; the sample showed high transmittance and low absorbance. Further, when dopants attached absorbance increased sample, it showed high absorbance, so it was the most active photocatalyst and absorbed the maximum visible light. The UV-Vis absorption spectra demonstrated that co-doping with Fe, S, and Co enhances the ability of photocatalysts to absorb in the visible light region.
[5] Cu-ZnO / TiO ₂	The XRD analysis confirmed the presence of crystalline Cu and ZnO on the TiO ₂ surface in the synthesized nanocomposite. The sharp diffraction peaks observed corresponded to planes of the hexagonal crystalline structure of wurtzite ZnO. The XRD pattern revealed the presence of mixed anatase and rutile phases of TiO ₂ in the prepared nanocomposite as the characteristic peaks for rutile TiO ₂ . The field emission scanning electron microscopy coupled to energy dispersive X-ray spectroscopy (FESEM-EDX) micrograph of the CZT-2 nanocomposite revealed the sharp peaks of Cu, Zn, O, and Ti elements only, assuring the existence of Cu, ZnO, and the detailed morphological characteristics of CZT-2 were assessed by HRTEM images. It also demonstrated that the synthesized nanocomposite photocatalyst displayed a nearly spherical shape with the average nanoparticle size comparable to the crystallite size, deduced using the Debye-Scherrer equation. CZT-2 nanocomposite fabrication exhibited uniform spherical Cu and Zn metal NPs with the particle size of the composite being about 25 nm, and even distribution of Cu and ZnO over the TiO ₂ surface is achieved successfully through the sonochemical approach. FTIR analysis confirmed the synthesis of CZT-2 via a sonochemical method through the co-existence of Cu, ZnO, and TiO ₂ . The band gap energy of the CZT-2 nanocomposite photocatalyst was estimated using UV-Vis-diffuse reflectance spectroscopy (UV-Vis-DRS). The CZT-2 nanocomposite photocatalyst absorbed the visible-light irradiation as the absorption edge was reflected around 470 nm. The diffuse reflectance spectrum of the CZT-2 revealed the linear region between 500 nm and 650, corresponding to the band edge absorption.
[38] C, N Co-doped TiO ₂	FTIR spectra revealed that the characteristic peaks suggest the presence of protein as the main component in the chicken egg white. The appearance of the Ti-C and Ti-N bonds in the co-doped TiO ₂ suggested

	<p>that C and N species have been incorporated into the TiO₂ lattice, probably through the substitutional of O atoms from TiO₂ by C and N dopant atoms. The characteristic pattern of TiO₂ crystal is noticeable in the XRD patterns of all TiO₂-C, N samples, with no detectable dopant-related peaks. On the other hand, the co-doping C, N into TiO₂ led to a decrease in the diffraction peak intensities, and the decrease was proportional to the weight of the egg white as the C, N dopant source. The decrease in the intensities implied a reduction in the crystallinity of TiO₂ due to the partial structural distortion. It is also exhibited that the more significant structural distortion of TiO₂ occurred as the egg white weight was enhanced since more C and N were doped. The crystal distortion proved that C and N from the white egg were successfully doped via a substitutional mechanism. For UV-Vis reflectance data, the respective Eg values were obtained, and it was found that a decrease in the Eg values provided evidence of the interstitial C and N co-doped mechanisms. TEM images of undoped and co-doped TiO₂ samples showed that TiO₂ particles have a spherical shape of various sizes. Also, it found that large compounds forming agglomerate blocked the TiO₂ surface. This implied the occurrence of the co-doping C and N from the chicken egg white to the TiO₂ crystal.</p>
<p>[6]</p> <p>Modified P25-TiO₂ with Cobalt-Carbon supported on SiO₂ matrix</p>	<p>The average particle size was calculated using SEM analysis by counting at least 500 particles. The particle size of the powder was approximately 200 nm. Co²⁺ and Co³⁺ ions appeared in XPS analysis of CoC@SiO₂-bipy (s1) prepared from pyrolysis of cobalt bipyridine chloride and XPS of CoHGC@SiO₂ prepared from cobalt phenanthroline sulphate complex, indicating that some cobalt atoms were oxidized to Co₃O₄. However, Power X-ray Diffraction analysis (PXRD) of these nanocomposites showed the presence of metallic cobalt. On the other hand, the TEM of CoC@SiO₂ showed a graphitized structure around the cobalt nanoparticle embedded in the silica matrix. The SEM analysis indicated that the cobalt nanoparticles pointed out from the surface of the silica and were surrounded by a tinny layer of graphitic carbon, facilitating the photodegradation because cobalt species improve the adsorption of Congo Red into the surface and the charge transfer. Also, SEM-EDX revealed that CoC@SiO₂-bipy (s1) showed weight %C = 34.5, %N = 4.1, %O = 21.0, %Si = 30.8, and %Co = 10.5, while CoHGC@SiO₂ nanocomposite had similar weight % distribution, but with higher cobalt and lower silicon content: %C = 36.4, %O = 20.4, %Si = 11.4, and %Co = 25.8. SEM images of pure TiO₂ and TiO₂/CoC@SiO₂-bipy (1) and TiO₂/CoC@SiO₂-phen (2). The pure P25-TiO₂ was spherical with uniform dispersion, with an average size particle diameter of 103.70 ± 05 nm, while the particle sizes of TiO₂/CoC@SiO₂-phen (2) nanocomposite increased to become more than 200 nm so that TiO₂/CoC@SiO₂-bipy (1) with a smaller particle size can show improved adsorption of Congo red onto the catalyst (1) and increased photocatalytic efficiency and larger size particles appeared after doping TiO₂ with CoC@SiO₂</p>

[8]	Bentonite / TiO ₂ quantum dots	<p>The FTIR spectra analysis showed a successful synthesis of Bent/TQ nanocomposites. In XRD analysis was found a characteristic peak for montmorillonite was at $2\theta = 5.69^\circ$, corresponding to a basal spacing of $d_{001} = 15.52 \text{ \AA}$, and the presence of quartz, a typical impurity in Bentonite, was confirmed, as same as the anatase phase of TiO₂. These peaks indicated that the anatase phase of TiO₂, known for its superior photocatalytic activity, remained stable under microwave irradiation. A comparative analysis of the XRD patterns demonstrated significant structural differences among pure Bentonite, TQ, and Bent/TQ nanocomposites. Pure Bentonite primarily exhibits peaks associated with montmorillonite and quartz, whereas the Bent/TQ nanocomposites displayed shifts in the montmorillonite peaks and the emergence of anatase TiO₂ peaks. This confirmed the successful integration of TiO₂ into the Bentonite matrix, enhancing its structural and photocatalytic properties. The SEM images suggested TQ's successful integration and aggregation within the Bentonite matrix. The incorporation of TiO₂ appeared to play an important role in dictating the final morphology, leading to a more homogenous distribution of smaller entities than the pristine Bentonite. TEM scans demonstrated the creation of nanoparticles with high crystallinity and an ellipsoidal shape. The resulting material exhibited a high specific surface area of $205.45 \text{ m}^2 \text{ g}^{-1}$ and an optimized band gap of 3.15 eV, making it suitable for visible light photocatalysis.</p>
[9]	Cr-doped into TiO ₂	<p>The material was characterized by UV-Vis diffuse reflectance, FTIR, X-ray diffraction, X-ray fluorescence, and SEM machines. The effect of the Cr-doping on the TiO₂ activity under visible light was evaluated through Congo red dye photodegradation by batch experiment and revealed that Cr-doping on TiO₂ had successfully proceeded, which could reduce the gap energy shifting into the visible region and further enhanced TiO₂ activity under visible light. It was also found that doping TiO₂ with Cr by the mole ratio of TiO₂ to Cr = 1:1 converted TiO₂ into a CrTi₂O₅ crystal that also showed photocatalyst properties. Also, the XRD analysis found that dopants formed a homogeneous solid solution with TiO₂.</p>
[10]	Cu ₂ O/TiO ₂ quantum dots (QD)	<p>XRD analysis indicated a face-centered cubic structure. The Cu₂O crystal had a cubic crystal structure in which an oxygen atom is present at the center, with Cu atoms occupying half of the tetrahedral sites. No diffraction peaks of Cu or CuO were observed, indicating the high purity of the synthesized material. Also, the high intensity of XRD peaks confirmed the particles' good crystallinity. The calculated sizes of TiO₂-QD and Cu₂O/TiO₂-QD were 12 nm and 58 nm, respectively. SEM images of Cu₂O particles showed an average size of $0.5 \text{ }\mu\text{m}$ and confirmed the truncated octahedron shape possessing 12 hexagonal (110) faces and 6 square (100) faces. The TEM technique also depicted the hollow truncated octahedron shape case (I) of Cu₂O. Cu₂O/TiO₂-QD composite shows strong absorption in the UV region and shifts to the visible region when the amount of Cu₂O increases.</p>

[11]	Doped TiO ₂ with Fe from rusty iron waste	<p>The UV-Vis spectra found that the Fe-doped TiO₂ samples had their absorption edge at longer wavelengths (λ), entering the visible region than the absorption of the undoped one. These absorption shifts allowed the doped TiO₂ to strongly absorb the visible light, which is hoped to show higher activity in the presence of visible light. In the spectra of all TiO₂-Fe samples, peaks at around 450 – 493 cm⁻¹ could be seen, which were the shifts from the peak of 509 cm⁻¹ belonging to the undoped TiO₂. The shifts indicated the disturbance of the Ti-O-Ti bond by the Fe dopant due to the interaction between oxygen atoms in the Ti-O-Ti bond with the Fe doped. That interaction indicated the occurrence of the interstitial doping mechanism. XRD analysis showed the anatase phase. Also, it demonstrated that Fe doping did not affect the crystal phase change. Moreover, the lower intensities indicated that the doped TiO₂ was in the less crystalline phase due to inhibiting the TiO₂ crystallinity growth. Such inhibition of the crystallographic growth is most probably affected by the Fe dopant inserted in the TiO₂ crystal lattice, which was well documented in previous works. Then, the absence of the dopant pattern implied that the Fe dopant had been successfully incorporated into the crystal lattice of TiO₂ due to the nearly identical ionic radius to that of the Ti⁴⁺ cation (0.0745 nm). The TEM analysis demonstrated the presence of Fe dopant atoms that have successfully entered the crystal lattice of TiO₂.</p>
[12]	V ₂ O ₅ -TiO ₂	<p>The XRD data analysis confirmed the formation of mixed phases of TiO₂ (anatase) and Ag₂O phase. The crystalline size varied from 48.0 nm to 44.6 nm, determined from XRD and verified from the TEM micrograph. The EDX measurements suggested that iron was incorporated entirely, but silver was not incorporated into the TiO₂ matrix. The optical band gap of the prepared nanoparticles was calculated by UV-Vis absorption spectroscopy using Tauc-Davis and Mott expression and was found to vary from 2.92 to 2.30 eV. The absorption bands in the UV-visible spectra shifted towards higher wavelength regions, and the appearance of emission bands in photoluminescence (PL) spectra confirmed the formation of energy substrates in the forbidden gap of the prepared samples. TEM micrographs showed that prepared nanoparticles had a somewhat spherical shape. The formation of different functional groups and bonds in the structure of synthesized nanoparticles, as observed in FTIR spectra, helped in the degradation of organic dyes (Congo Red and methyl orange) and enhanced the photocatalytic activity under visible light. It was observed that the higher doping concentration of silver caused a decrease in the band gap energy. As a result, the carrier recombination rate decreased, enhancing the degradation efficiency.</p>
[13]	Bimetallic Au-Pd / TiO ₂	<p>The analysis of UV-Vis spectra found the resonance band of the Au and Pd mixture was set at 350 nm and 500 nm. The Au UV-Vis spectrum was recorded, and a total reduction was observed in the Au (III) species. The presence of the plasmon resonance seen at 500 nm is considered a characteristic of the gold nanoparticles with particle dimensions smaller than 10 nm. Furthermore, the study confirmed the UV-Vis</p>

		<p>spectrum of Au-Pd sol, demonstrating a decrease in the absolute (AuCl_4^-). According to TEM analysis, for carbon-supported Au-Pd colloid, the mean particle sizes were 5.5 ± 0.9, while the mean particle sizes were 14.2 ± 0.9 nm for Au-Pd supported titanium. Compared to carbon, the study observed a minor rise in particle dimension after the colloid was immobilized on TiO_2. In the EDX and FESEM analysis, the nanoparticles were well dispersed on the surfaces of the TiO_2 and activated carbon. The two images also revealed that the catalyst particles were distributed homogeneously due to the small size of the particles of the Au-Pd. A slight disparity was observed in the particle size distribution between samples of Au-Pd/TiO_2 and Au-Pd/C. Au-Pd/C had a better and more homogeneous particle size distribution, which could result from the smaller particle size of the carbon support. In the Brunauer-Emmet-Teller (BET) surface area analysis, the catalyst's surface area was found that 1 wt% (Au-Pd)/C catalyst showed more activity compared to the 1 wt% Au/TiO_2 catalyst. In the XRD analysis, the samples detected exhibited a cubic crystal shape system.</p>
[14]	Sol-Gel immobilized TiO_2 thin layers	<p>SEM-EDX analysis confirmed the presence of TiO_2 on the silica glass support. Also, it showed significant concentrations of Ti and O, which were elements composing the TiO_2 thin film layer. On the other hand, Na, Al, and Si were elements constituting the glass tube, predominantly Si indicating the presence of silicate in the glass tube. SEM photo measurement results demonstrated the presence of TiO_2 immobilized on the inner wall of the glass tube. The XRD measurement of the TiO_2 catalyst showed ten peaks, which indicated that the synthesized TiO_2 used in this study had an anatase crystal structure. The UV-Vis analysis showed an increase in absorption in the wavelength range between 300 – 400 nm - a characteristic feature of TiO_2 crystals - attributed to electron transitions from the valence band to the conduction band with energy gaps of 3.0 eV (rutile) and 3.2 eV (anatase). The gravimetric analysis found an optimal TiO_2 loading level (eight layers of TiO_2 coating). It could be estimated at 0.1007 mg/cm^2, with the thickness of the TiO_2 layer adhered to the inner wall of the glass tube measuring $0.6128 \mu\text{m}$.</p>
[16]	Cuprous oxide/ titanium dioxide and cuprous oxide/zinc oxide p-n heterojunction photocatalyst	<p>XRD analysis confirmed the presence of Cu_2O, a cubic structure, high purity, good crystallization, and anatase crystal plane, and the zincite phase coexisted with the cubic Cu_2O phase in the composite. The average crystallite size was 22.89 nm. The XPS analysis revealed binding energies of 529.9, 531.4, and 531.9 eV of the O 1s spectrum and can be assigned to the respective oxygen in Ti-O, Cu-O, and -OH. The TEM picture of TiO_2 found that nanoparticles with an irregular shape were dispersed along with spherical Cu_2O nanoparticles having an average size of 6 nm. In the optical analysis, the band gap increase resulted from the composite formation with TiO_2 and ZnO. TiO_2 and ZnO are well-known n-type and wide band gap semiconductors absorbed at the UV region, while Cu_2O was a narrow band gap p-type semiconductor, which absorbed at the visible region. Thus, the increase in Cu_2O's band gap demonstrated that the composites absorbed in the</p>

	<p>visible region with less recombination of charges compared to pristine Cu₂O. The FTIR analysis found bands corresponding to the Ti–O modes, Ti–OH, Cu–O, Cu₂O, and TiO₂ bands, and the vibrational modes corresponded to Cu₂O and TiO₂ and anatase phase. In the PL analysis, after introducing TiO₂ and ZnO, the PL intensity was significantly quenched, which implied the lowest recombination rate (i.e., regeneration of the photo-induced electron and hole because of the Cu₂O heterojunction formation).</p>
<p>[17]</p> <p>In³⁺ and Sb⁵⁺ doped and co-doped TiO₂ semiconductor</p>	<p>The XRD proved that pure TiO₂ and Ti_{0.97}In_{0.03}O₂ powders had a single tetragonal anatase phase structure, while Ti_{0.97}Sb_{0.03}O₂ and Ti_{0.94}In_{0.03}Sb_{0.03}O₂ compositions had mixed phases of anatase and brookite. The SEM images revealed that Ti_{0.94}In_{0.03}Sb_{0.03}O₂ powder had fine and homogenous particles. The TEM images confirmed that Ti_{0.94}In_{0.03}Sb_{0.03}O₂ powder had the lowest mean particle size of 20 nm. The visible light response of TiO₂ was significantly enhanced due to the addition of Sb⁵⁺ and In³⁺/Sb⁵⁺ ions. The calculated band gap energies of TiO₂, Ti_{0.97}In_{0.03}O₂, Ti_{0.97}Sb_{0.03}O₂, and Ti_{0.94}In_{0.03}Sb_{0.03}O₂ samples are 3.35, 3.21, 2.97, and 2.91 eV, respectively.</p>
<p>[18]</p> <p>Ternary TiO₂/Y₂O₃@ g-C₃N₄ nanohybrid</p>	<p>XRD analysis and transmission electron microscopy coupled with elemental chemical composition confirmed the formation of a network-like nanostructure composed of Y₂O₃/TiO₂ nanoparticles coupled with g-C₃N₄ nanosheets. The estimated pore diameter was 15.7 Å, an average pore volume of 0.243 cm³ g⁻¹, and a Surface BET area of 115.04 m² g⁻¹. Due to its large surface area, low band gap energy, and the presence of photogenerated holes, electrons, and hydroxyl radicals, the nanohybrid composite exhibited excellent photocatalytic degradation. According to XPS analysis, no contaminant was present within the fabricated TiO₂/Y₂O₃@g-C₃N₄ nanocomposite, confirming the purity of the powdered samples. According to UV-Vis spectroscopy, the TiO₂/Y₂O₃@g-C₃N₄ absorption edge shifted toward visible light. Thus, it is markedly reduced while increasing within the 450 – 600 nm range.</p>
<p>[19]</p> <p>Z-Scheme CuO@ TiO₂@ halloysite heterostructure</p>	<p>XRD analysis found that, when comparing composite to pure TiO₂ and CuO, the respective planes of composite moved to the right, confirming the successful synthesis of composite. Also, the composites revealed prominent peaks correlated to HNT, TiO₂, and CuO, indicating the successful synthesis of composite materials without any detectable impurities. The FTIR analysis evidenced the loading of CT on the HNT surface. The XPS data concluded that TiO₂, CuO, and HNT interacted electronically strongly, developing the heterojunction with good charge migration. Electron spin resonance (ESR) analysis revealed that the surface hydroxyl groups of clay facilitated the formation of oxygen vacancies in the composite via heat-induced dehydration; this led to enhanced adsorption and catalytic capabilities of composite materials. BET and Barrett-Joyner-Halenda (BJH) analysis determined that the composite exhibited a pore volume of 0.413 cc/g. The zeta potential values of CT, 5,10, 20, and 30CT-HNT were found to be -36.2, -40, -42.9, -50.8, and -46.6 Ev, respectively. Based on the</p>

		thermogravimetric Analysis (TGA) results, the composite exhibits favourable thermal stability at up to 800 °C.
[20]	Z-Scheme CuO@ TiO ₂ @ halloysite heterostructure	According to SEM images, the carbon nanotubes (CNTs)/Ag was 10:1, and the CA composite with a uniform surface coating of AgNPs could be obtained. When the content of CA was 10%, TiO ₂ was not uniformly dispersed on the surface of CA, which might be due to the low content of CA, which could not provide sufficient active sites, which made TiO ₂ particles agglomerate together. When the content of CA was 15% and 20%, the TiO ₂ loaded on the surface was not agglomerated on a large scale, indicating that TiO ₂ particles were well attached to the surface of samples. Also, the energy spectrum analysis of CAT samples with 10% CA content was tested. The EDX spectrum of nanocomposite confirmed the presence of Ti and AgNPs. The sample showed that TiO ₂ was evenly dispersed, AgNPs were coated on CNTs' surface well, and the three components were evenly distributed. FTIR analysis confirmed the presence of CNTs and TiO ₂ incorporation. The XRD analysis confirmed a typical graphite sheet's anatase phase and crystal plane.
[21]	TiO ₂ quantum dots (TDS)	The characterization was carried out using XRD, XPS, TEM, and FTIR verified the high crystallinity, anatase phase purity, and nano-scaled dimensions of the produced TDS particles. XRD analysis indicated increased crystallite size from 3.1 to 8.5 nm with increasing calcination temperature. XPS confirmed Ti, O, and C chemical states in TDS1. TEM imaging revealed spherical, elongated nanoparticles with sizes consistent with XRD data and high crystallinity. FTIR identified characteristic Ti–O–Ti vibrations in TDS. Optical characterization showed the bandgap energy decreased from 3.09 to 2.97 eV for TDS1 to TDS3, respectively, due to the quantum confinement effect of the smaller 3.1 nm particles. Correspondingly, TDS1 exhibited a large surface area of 357.14 m ² g ⁻¹ .
[22]	TiO ₂ / Cellulose biochar	The characteristics of cellulose biochar/ TiO ₂ composites were studied using XRD, SEM, SEM-EDX, FTIR, TGA, and zeta potential analyses. As a result, it was revealed that the anatase and rutile phases of TiO ₂ had been detached and distributed on the cellulose biochar surface of the composite materials. EDX results showed mainly carbon, oxygen, and titanium elements.
[23]	Bismuth-doped Tin-dioxide	UV-Vis spectroscopy, SEM, and XRD characterized the synthesized catalyst in both forms. The XRD analysis revealed that the calcination of the Bi-SnO ₂ improved its crystallinity, and no peaks from the impurity- such as oxides of bismuth or tin- were detected. This shows that the current method could effectively synthesize the Bi-SnO ₂ photocatalyst. The SEM showed that the Bi-SnO ₂ had an average size of less than 150 nm.
[54]	Magnetically recyclable wool / Fe ₃ O ₄ @ TiO ₂ /	XRD analysis revealed that Cu-doped TiO ₂ showed an average crystallite size of 8.15 nm. XRD patterns did not exhibit any recognizable CuO phase peaks. Furthermore, XRD results did not confirm whether CuO is found as an interfacial or nano-dispersed

UiO-66 structured composite	core-shell	phase on a surface. Also, it could be determined from the XRD studies that Cu^{2+} replaced Ti^{4+} in the TiO_2 anatase lattice structure, which lowered the lattice parameters. FTIR analysis found that Cu atoms replaced Ti in the substitutional anatase sites and were integrated into the interstitial anatase sites. The UV-Vis spectra revealed that, as Cu-concentration increases, the transmittance in the visible area gradually decreases, reaching 3 wt% for the 2 wt% doped TiO_2 sample. SEM analysis found that most particles were spherical and had a constant size distribution. Cyclic voltammetry detected the Cu (II) to Cu (I) oxidation process in the anodic sweep. This means that copper ions in the Cu-doped TiO_2 system were oxidized from the +2 oxidation state (Cu (II)) to the +1 oxidation state (Cu(I)).
[24] Magnetically recyclable wool / $\text{Fe}_3\text{O}_4@ \text{TiO}_2$ / UiO-66 structured composite	core-shell	The Rietveld refinement method confirmed that the TiO_2 material was anatase crystal when the calcination temperature was lower than 600 °C. On the other hand, when the calcination temperature was between 600 and 750 °C, the TiO_2 material was anatase-rutile mixed crystal, and the proportion of rutile increased gradually. The content of the rutile crystal reached 98.3 % at 800 °C. Compared with TiO_2 -PDM at 800 °C, TiO_2 -PDM at 500 °C has a smaller crystal size and better dispersibility.