

Supplementary Information

Titanium dioxide incorporated in cellulose nanofiber hybrid induced enhanced UV blocking performance by eliminating ROS generation

Iqra Rabani¹, Ha-Na Jang¹, Ye-Ji Park¹, Muhammad Shoaib Tahir¹, Yun-Bi Lee¹, Eun-Yi Moon², Jin Won Song³ and Young-Soo Seo*¹

¹*Interface lab, Department of Nanotechnology and Advanced Materials Engineering and*

²*Department of Bioscience and Biotechnology, Sejong University, Seoul 05006, Korea*

³*Fine Lab Co., Ltd. 97, Sinilseo-ro 126 beon-gil, Daedeok-gu, Daejeon, Korea,*

*Corresponding author's e-mail: ysseo@sejong.ac.kr

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Figure S24. Photocatalysis experiment of pristine TiO₂ for the Rho-B after subjected the UVB illumination for 300 min.

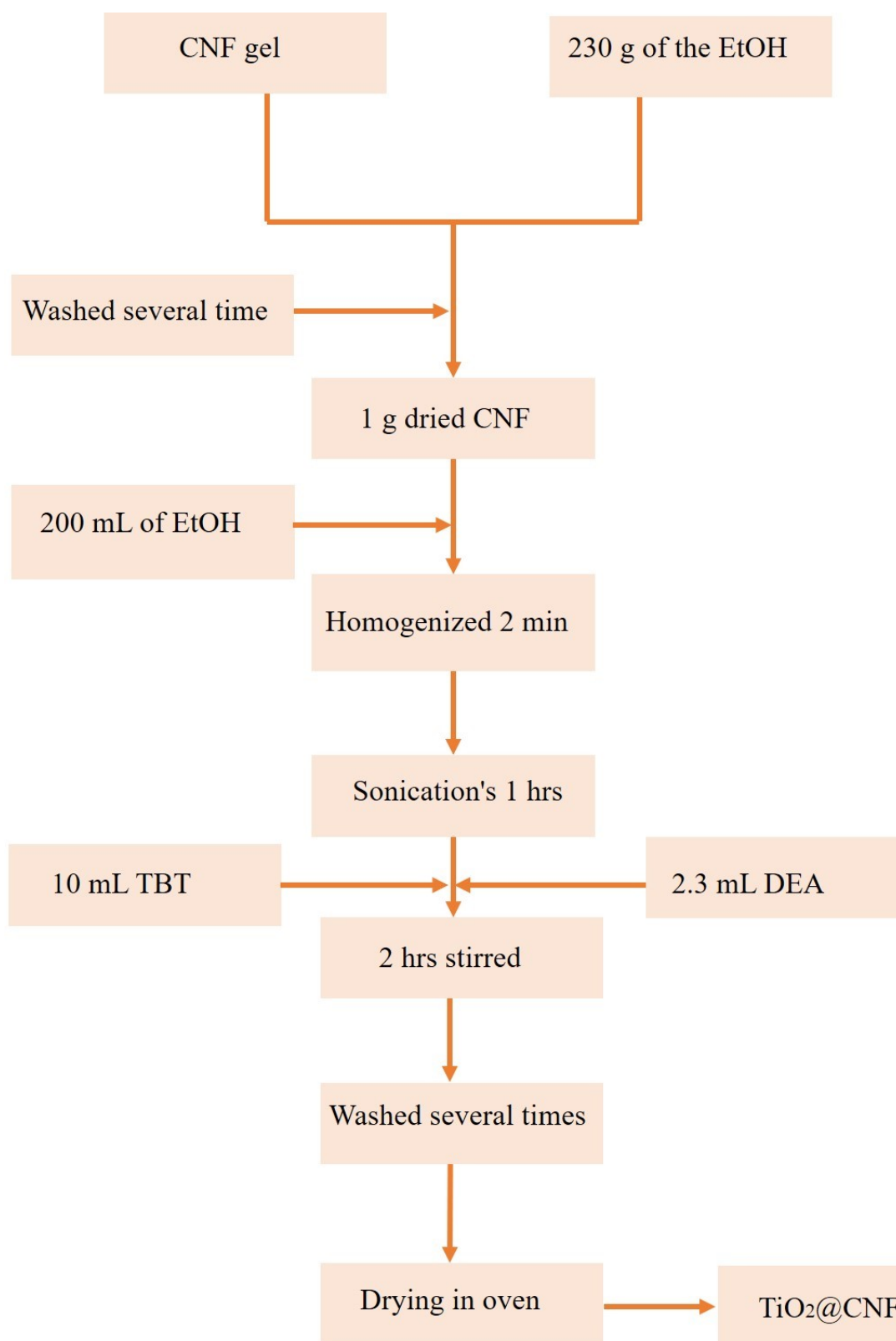


Figure S1. Flow chart for the synthesis steps of the TiO₂@CNF hybrid nanostructure through sol-gel method.

S2. Ingredients of the inorganic sunblock (HERA sun mate daily with SPF 35+)

Active ingredients:

1. Ethylhexyl methoxycinnamate
2. Bis-Ethylhexyloxyphenol methoxyphenyl triazine
3. Zinc Oxide
4. Titanium Dioxide

Inactive ingredients:

Water, Cyclopentasiloxane, Butylene Glycol, Propanediol, C12-15 alkyl benzoate, Isoamyl p-methoxycinnamate, Glyceryl Stearate, C14-22 alcohols, Camellia Sinensis Leaf Oil, Beta-Glucan, Rhodiola Rosea Root Extract, Helianthus Annuus Seed Extract, Pisum Sativum Extract, Yeast Extract, Khaya Senegalensis Bark Extract, Cassia Alata Leaf Extract, Hydrolyzed Millet, Tocopheryl Acetate, Arginine, Mannitol, Pyridoxine HCL, RNA, Histidine, Maltodextrin, Phenylalanine, Tyrosine, Acetyl tyrosine, Nicotinamide adenine, dinucleotide, Glycerin, Pentylene, Glycol Ethylhexyl Glycerin, Phenethyl Benzoate, Di caprylyl Carbonate, Polyisobutene, Stearyl behenate, Disodium succinate, Dimethicone, Hydroxypropyl Bispalmitamide MEA, Inulin Lauryl Carbamate, Cetearyl Alcohol, Stearic Acid, Aspartic acid, Myristic acid, Polyhydroxy stearic acid, Ammonium Acryloyldimethyltaurate, VP Copolymer, Polyacrylate-13, Carbomer, Polymethyl Methacrylate, Polysorbate 20, Methoxy PEG-114/ Polyepsilon Caprolactone, C12-20 Alkyl Glucoside, Polyglyceryl-3 methyl glucose, Di stearate, Silica, Aluminium stearate, 1,2-Hexanediol, Disodium EDTA, Phenoxyethanol, Fragrance.

S3. Ingredients of the inorganic sunblock (The face shop natural sun eco super perfect sun bock with SPF life 50+)

Active ingredients:

5. Avobenzone
6. Octinoxate
7. Octisalate
8. Titanium Dioxide

Inactive ingredients:

Water, Cyclopentasiloxane, Di caprylyl carbonate, Octyl dodecyl neopentanoate, Silica, Methicone, Polyglyceryl-6 polyricinoleate, Propanediol, Cyclohexasiloxane, Alcohol denat, Octocrylene, Polyglyceryl-6, Stearate, Polyglyceryl-6, Behenate, Caprylic/capric glycerides, Capryl hydroxamic acid, Peg-100 stearate, Glyceryl stearate, Potassium cetyl phosphate, Cetyl alcohol, Hydroxyethyl acrylate/sodium, Acryloyl dimethyl taurate copolymer, Squalene, Polysorbate 60, Polyethylene, Panthenol, Caprylyl glycol, 1,2-Hexanediol, Illicium verum (anise) fruit extract, Acrylates/vinyl isodecanoate cross polymer, Xanthan gum, Polyester-5, Potassium hydroxide, Trisodium edta, Helianthus annuus (sunflower) sprout extract, Sodium benzoate, Menthyl PCA, Sodium PCA, Fragrance.

S4. Ingredients of organic sunblock (MediFlower Suncream with SPF 50+)

Active ingredients:

1. Diethylamino Hydroxybenzoyl Hexyl Benzoate
2. Octocrylene
3. Bisethylhexyloxyphenol methoxyphenyl Triazine
4. Ethylhexyl Methoxycinnamate

Inactive ingredients:

Purified water, Homosalate, Methyl methacrylate crosspolymer, Ethylhexyl Salicylate, Butylmethoxydibenzoylmethane, C12-15 Alkylbenzoate, Hydrogenated Polydecene, Phenylbenzimidazole sulfonic acid, Butylene Glycol, Dipropylene glycol, Niacinamide, Silica, Glyceryl Stearate, cetearyl alcohol, Cetearyl olivate, Peach Tree Flower Extract, egg extract, pentylene glycol, Elder Flower Extract, glycerin, Damask rose water, Everlasting Extract, tea tree leaf water, Sorbitan Oliveate, Polysorbate 60, Dimethicone, Polyacrylate-13, sodium hydroxide, PEG-100 Stearate, Sorbitan Stearate, Polyisobutene, Tocopheryl Acetate, lemon peel oil, Bergamot Fruit Oil, BHT, Polysorbate 20, Adenosine, Sorbitan isostearate, orange peel oil, lime oil, Old Jujube Tree Leaf Oil, Eucalyptus leaf oil, Panthenol, Disodium EDIT, Phenoxyethanol, Caprylyl glycol, Ethylhexylglycerin, 1,2-Hexanediol

S5. Ingredients of organic sunblock (V10 UV shield with SPF 50+)

Active ingredients:

1. Octocrylene
2. Ethylhexyl Methoxycinnamate
3. Bisethylhexyloxyphenol methoxyphenyl Triazine
4. Diethylamino Hydroxybenzoyl Hexyl benzoate

Inactive ingredients:

1,2-Hexanediol, C12-15 Alkyl Benzoate, Glyceryl Oleate, Niacinamide, Beta-Carotene, Dipropylene, Glycol, Lavandula Angustifolia (Lavender) Oil, Lavandula Angustifolia (Lavender) Extract, Aniba Rosaeodora (Rosewood) Wood Oil, Panthenol, Linoleic Acid, Macadamia Ternifolia Seed Oil, Centella Asiatica Extract, Biotin, Brassica Oleracea Italica (Broccoli) Extract, Cyanocobalamin, Water, Xanthan Gum, Butylene Glycol, Sodium Hyaluronate, Glycerin, Mentha Piperita (Peppermint) Extract, Vitis Vinifera (Grape) Root Extract, Folic Acid, Propolis Extract Yeast Extract, Hydroxyacetophenone, Dimethicone Allantoin, Gossypium Herbaceum (Cotton) Flower Extract, Eucalyptus Alba Leaf Extract, Mangifera Indica (Mango) Leaf Extract.

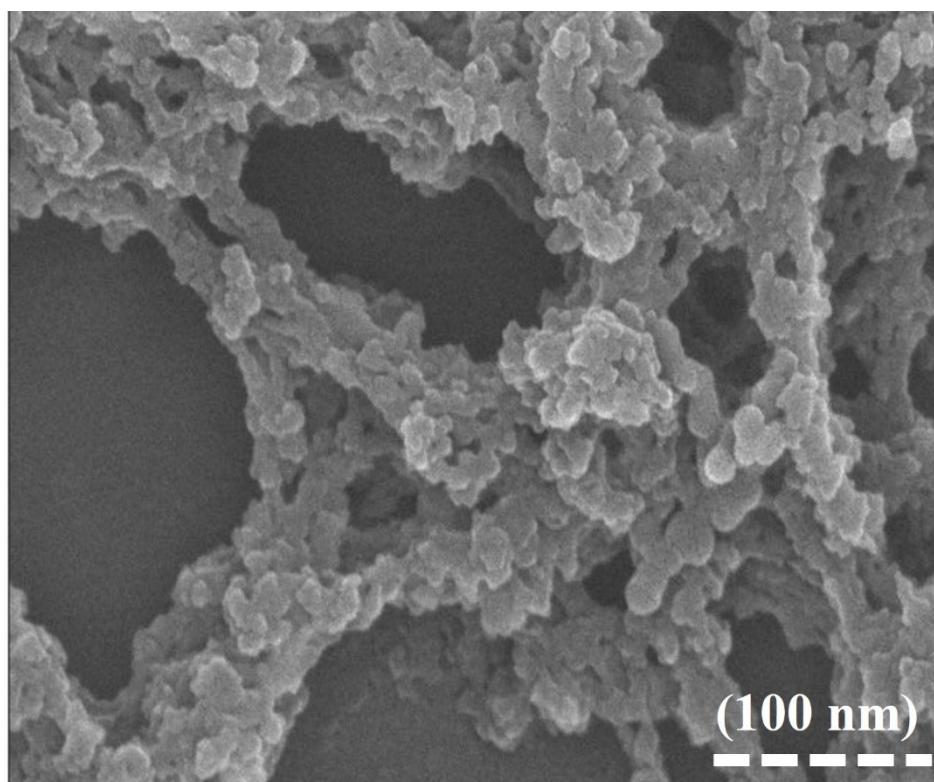


Figure S6. FESEM image of the $\text{TiO}_2@\text{CNF4}$ hybrid nanostructure with the concentration of the 0.24 wt.%.

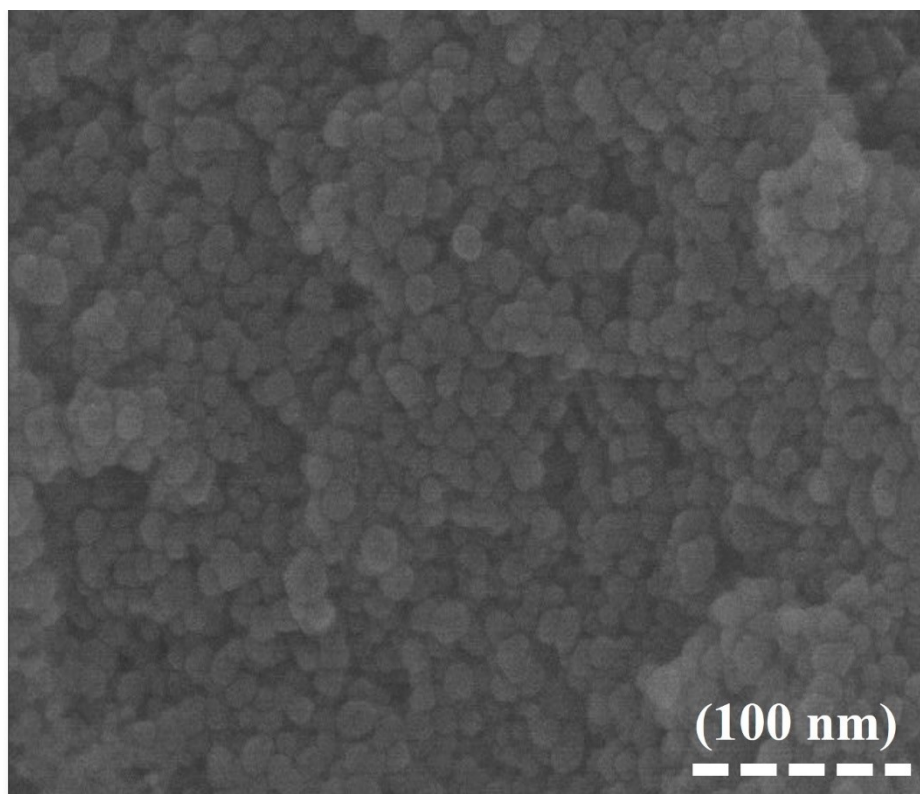


Figure S7. FESEM image of the TiO₂ without CNF.

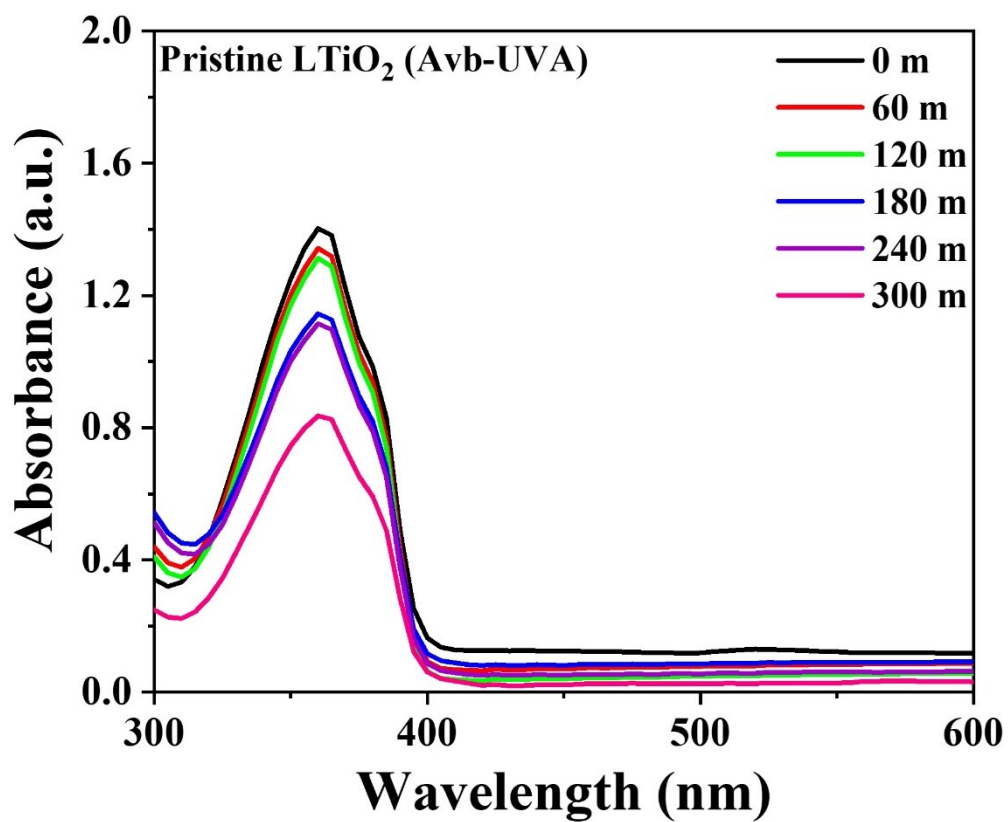


Figure S8. Avobenzone compatibility for the pristine TiO_2 NPs at lower concentration under UVA illumination.

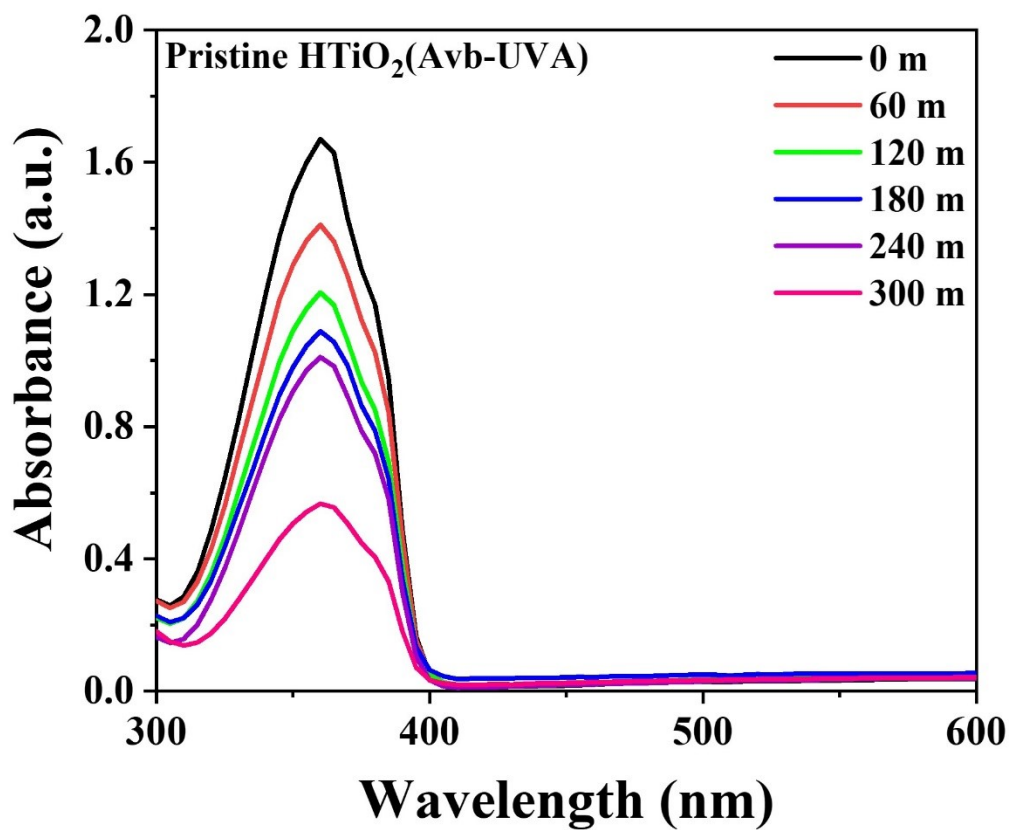


Figure S9. Avobenzone compatibility for the pristine TiO₂ NPs at higher concentration under UVA illumination.

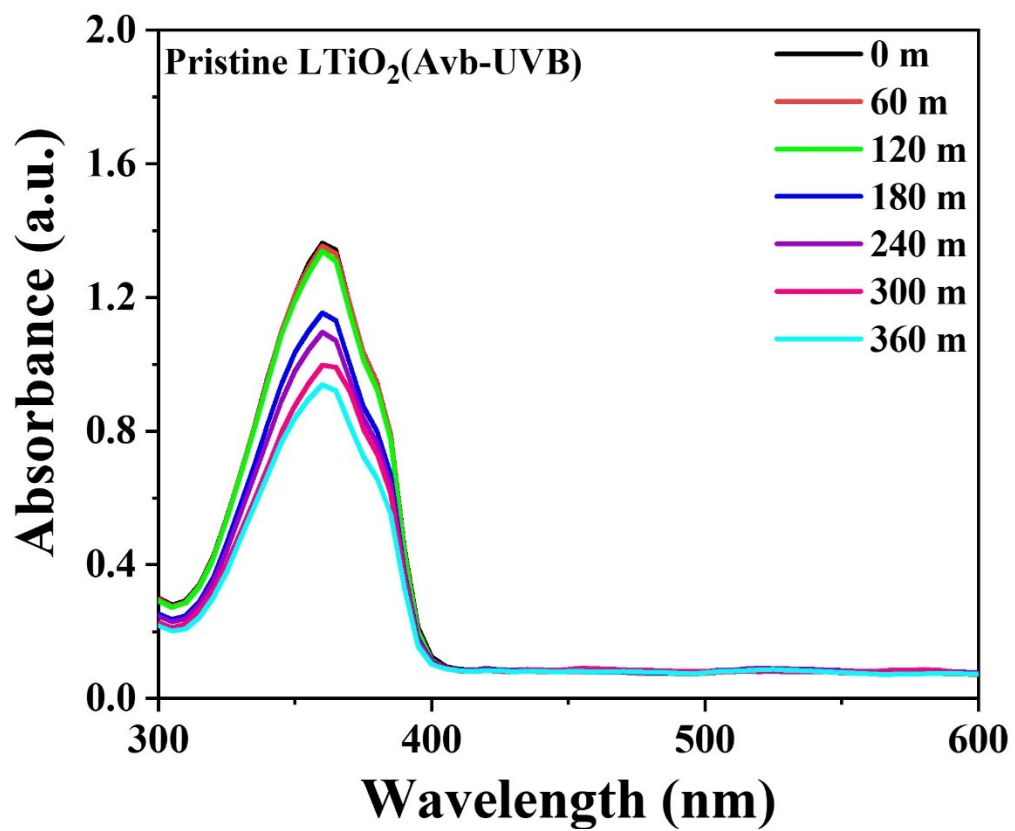


Figure S10. Avobenzone compatibility for the pristine TiO₂ NPs at lower concentration under UVB illumination.

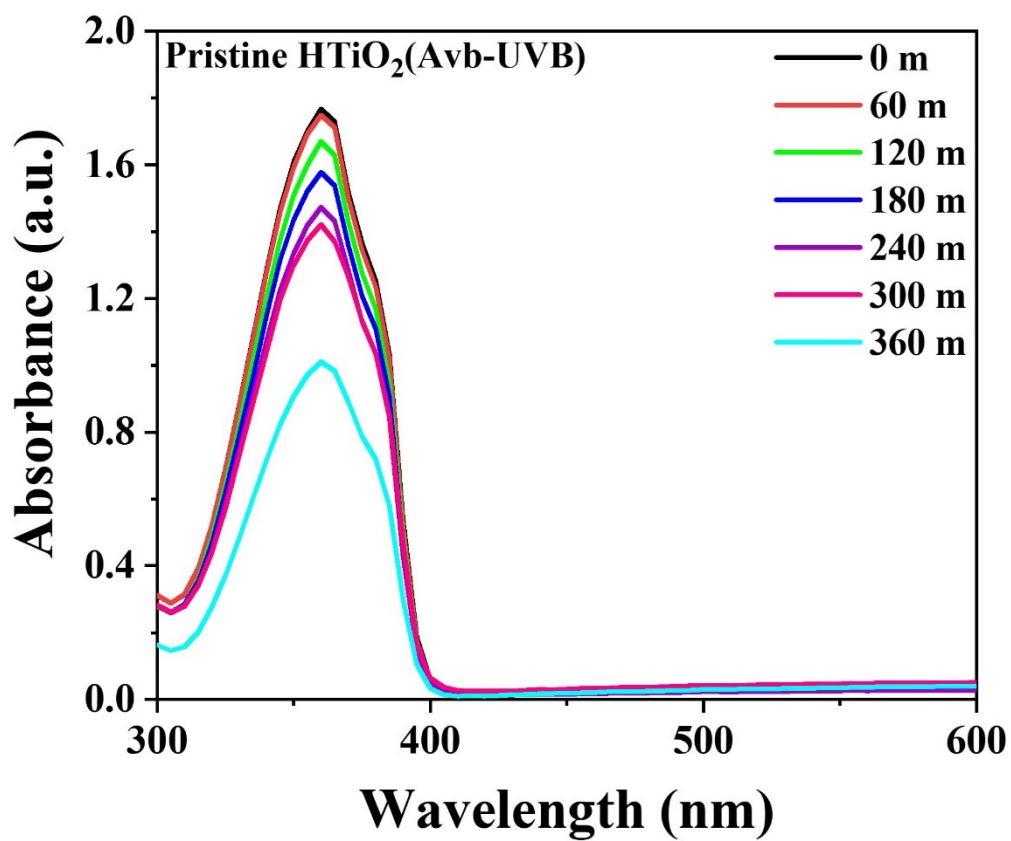


Figure S11. Avobenzone compatibility for the pristine TiO₂ NPs at higher concentration under UVB illumination.

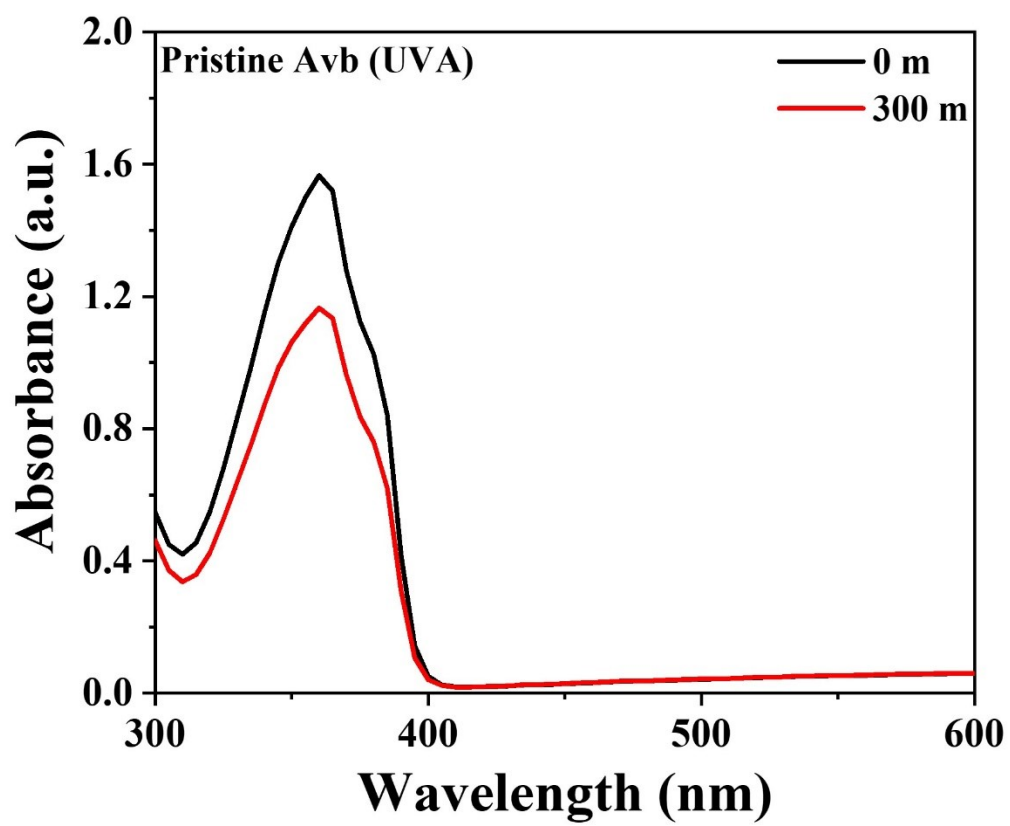


Figure S12. Avobenzone photocompatibility with UVA illumination.

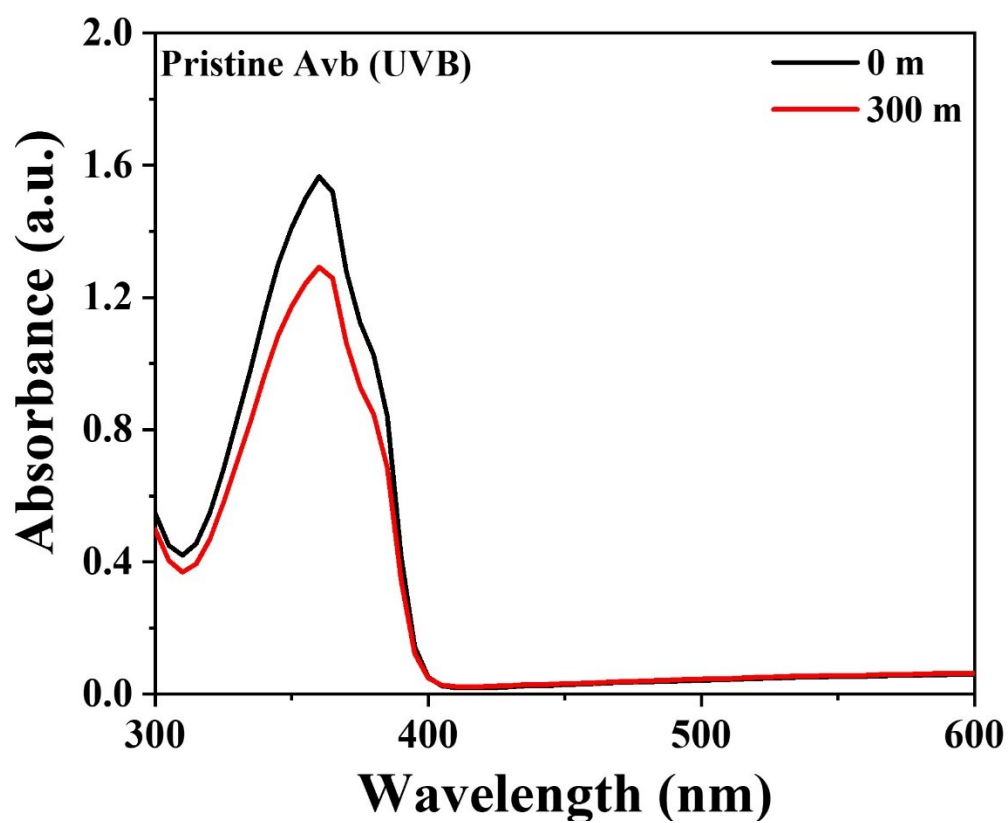


Figure S13. Avobenzone photocompatibility with UVB illumination.



Figure S14. Whitening effect of the modified sunblock's with CNF at the high and low concentrations i.e., **(i)** oSB1 (50+), **(ii)** oSB1(50⁺) + 5g CNF, **(iii)** oSB2(50+), **(iv)** 2SB1(50⁺) + 5g CNF, **(v)** ioSB1(35+), **(vi)** ioSB1(35⁺) + 5g CNF, **(vii)** ioSB2(50⁺) and **(viii)** ioSB2(50⁺) + 5g CNF.

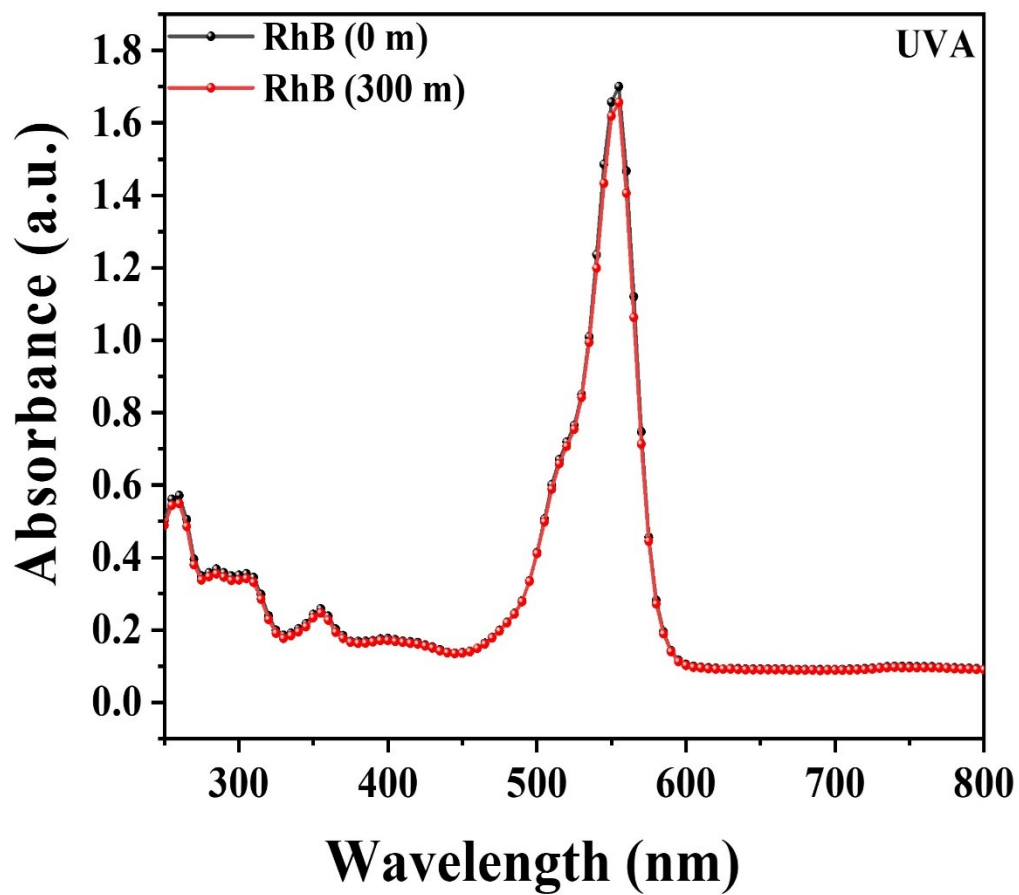


Figure S15. Photolysis experiment for the Rho-B after subjected the UV illumination for 300 min such as UVA illumination.

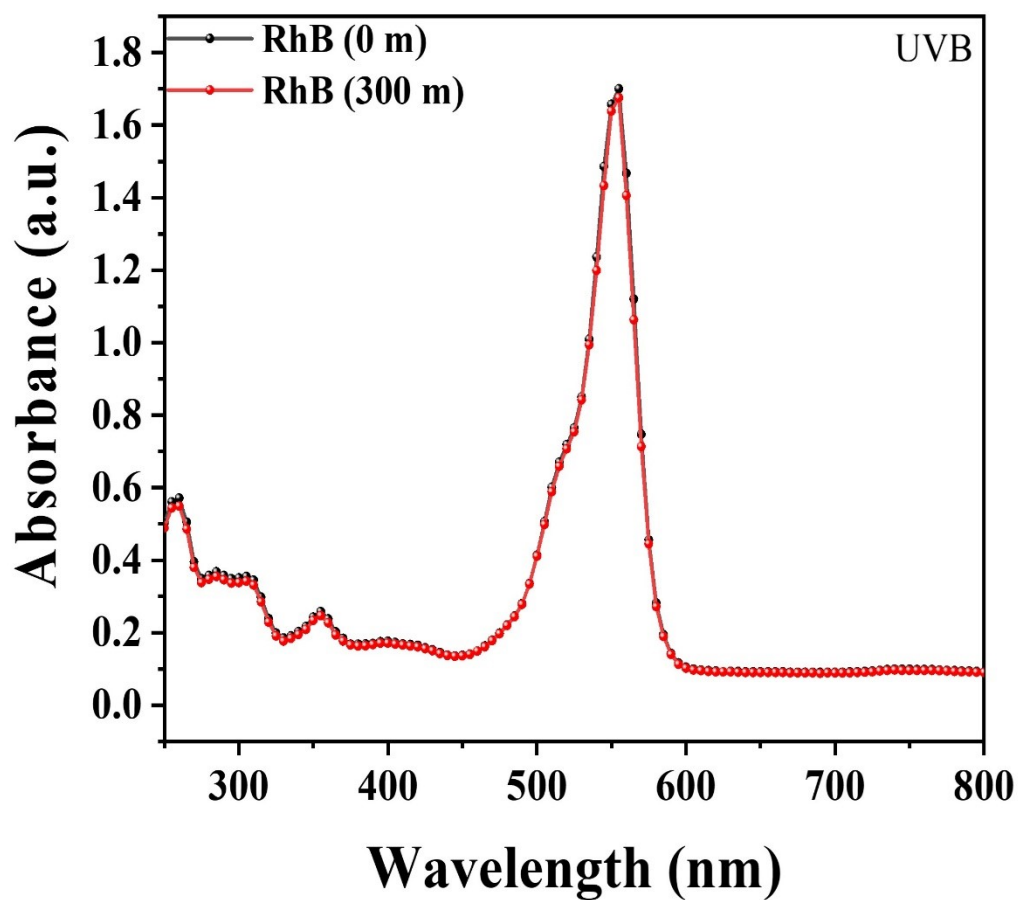


Figure S16. Photolysis experiment for the Rho-B after subjected the UV illumination for 300 min such as UVB illumination.

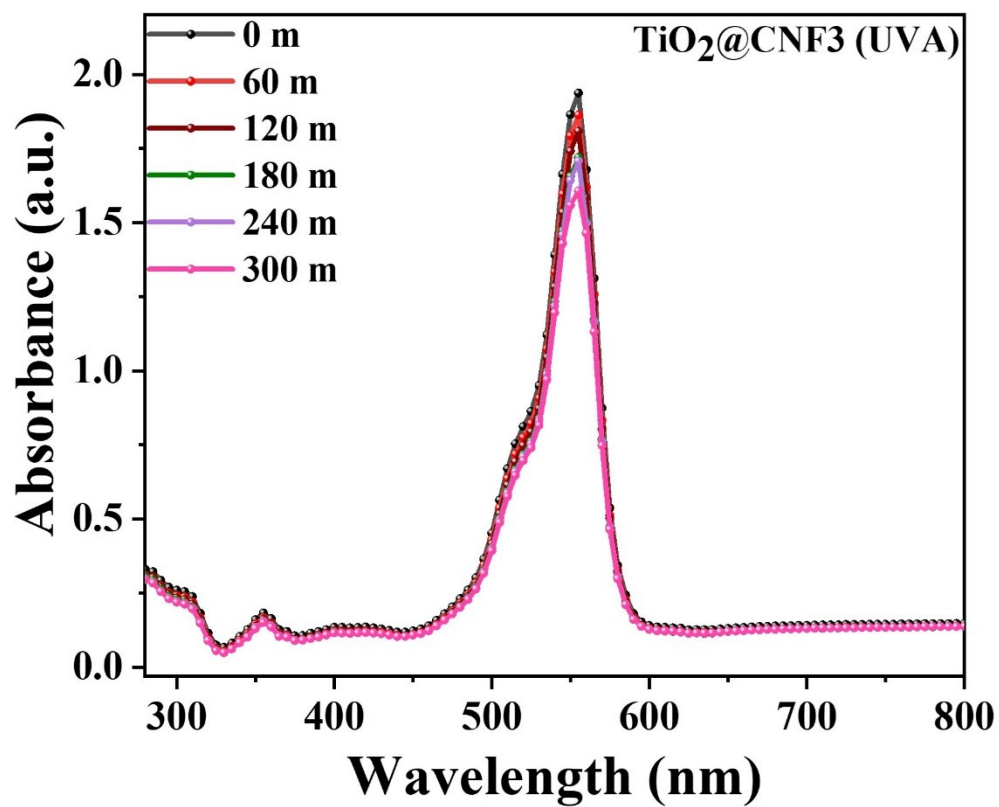


Figure S17. Photocatalysis experiment of TiO₂@CNF3 hybrid for the Rho-B after subjected the UVA illumination for 300 min.

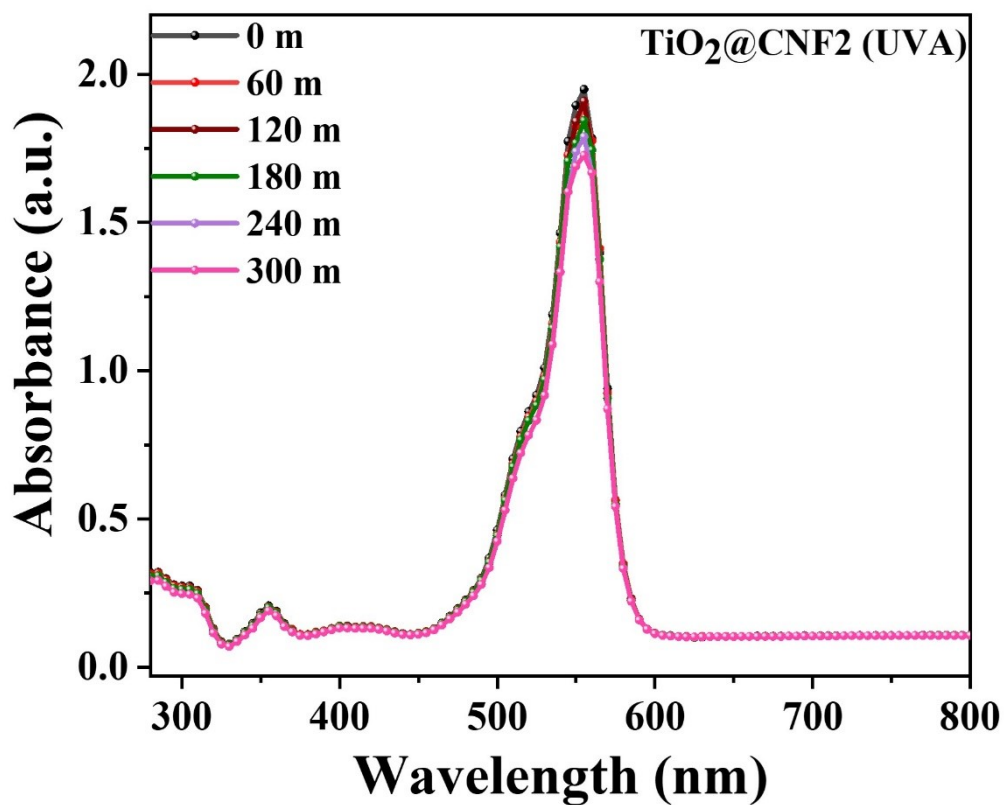


Figure S18. Photocatalysis experiment of TiO₂@CNF2 hybrid for the Rho-B after subjected the UVA illumination for 300 min.

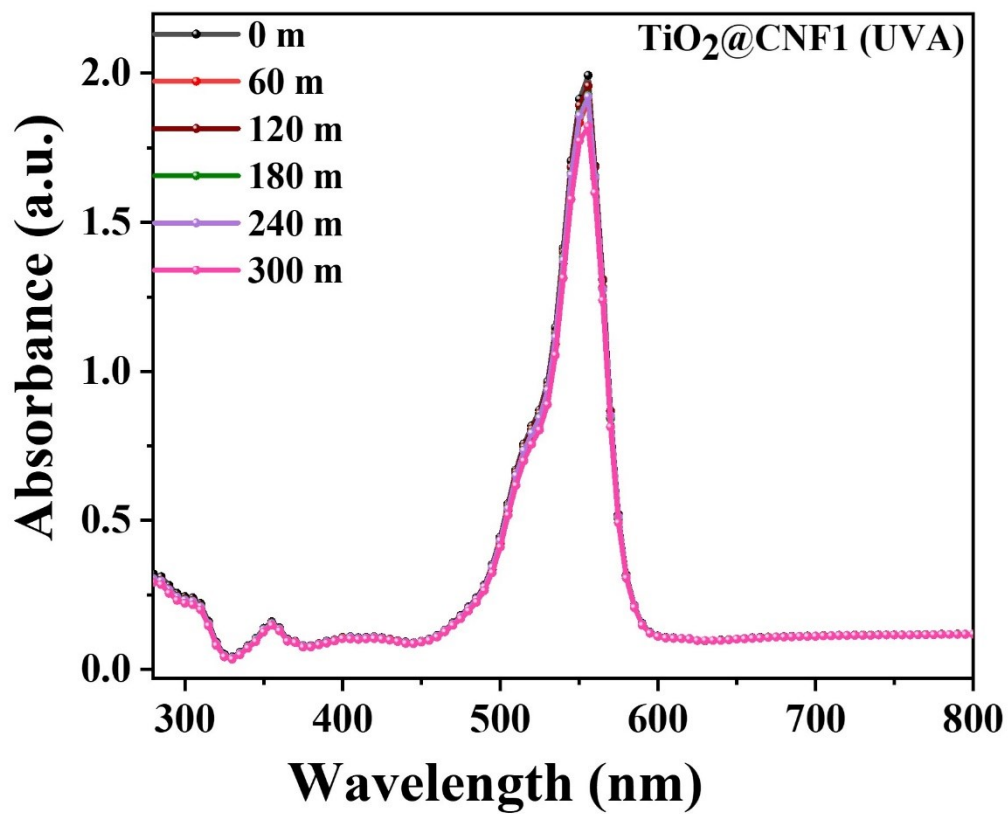


Figure S19. Photocatalysis experiment of TiO₂@CNF1 hybrid for the Rho-B after subjected the UVA illumination for 300 min.

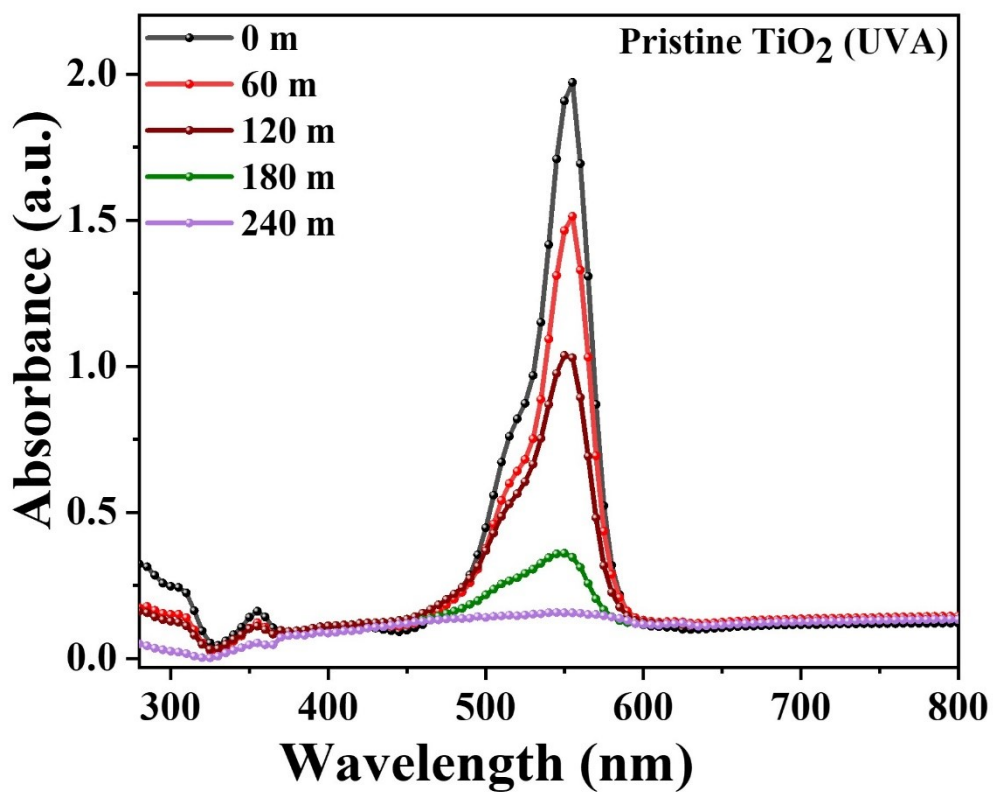


Figure S20. Photocatalysis experiment of pristine TiO₂ for the Rho-B after subjected the UVA illumination for 300 min.

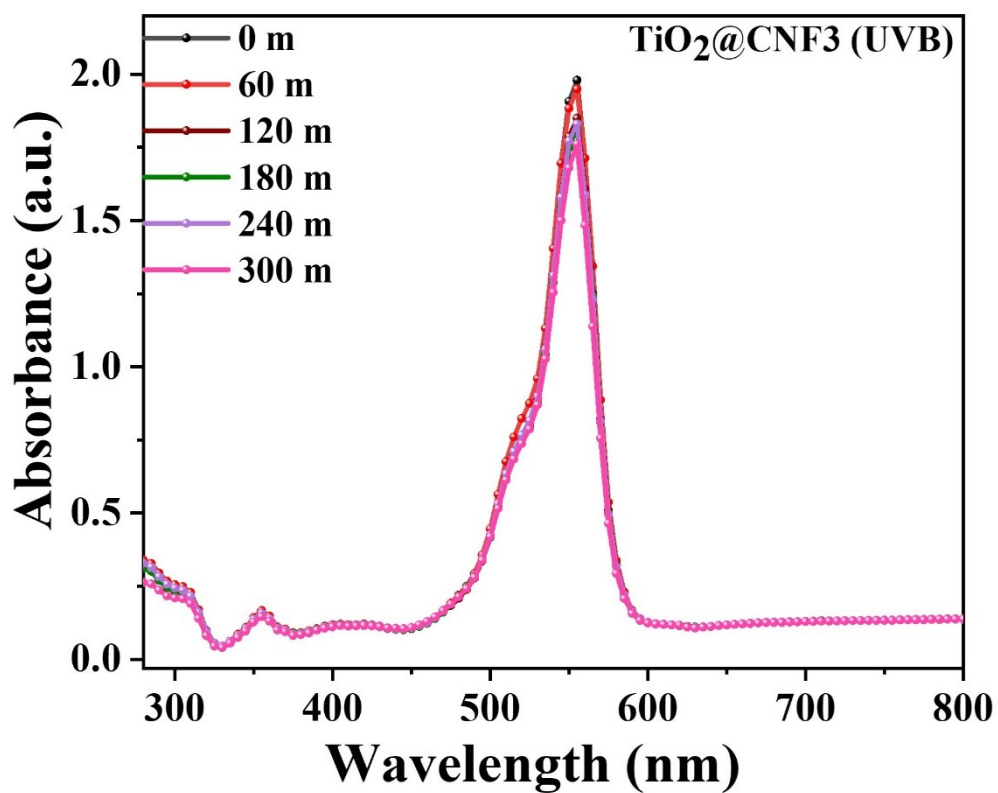


Figure S21. Photocatalysis experiment of TiO₂@CNF3 hybrid for the Rho-B after subjected the UVB illumination for 300 min.

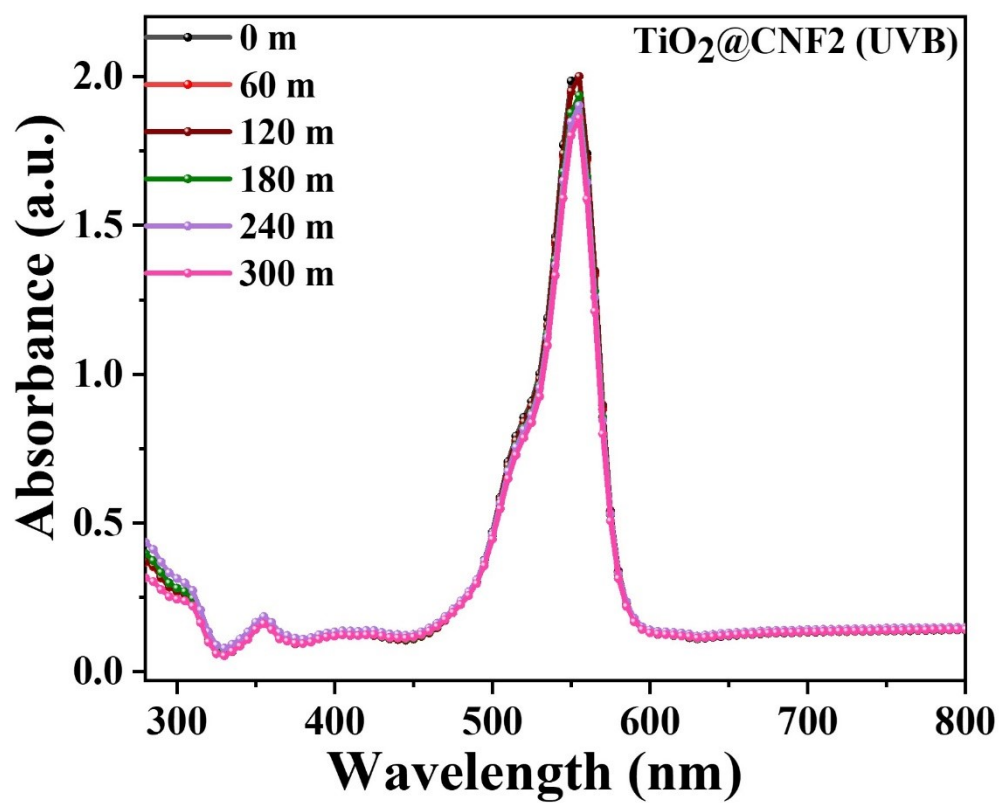


Figure S22. Photocatalysis experiment of TiO₂@CNF2 hybrid for the Rho-B after subjected the UVB illumination for 300 min.

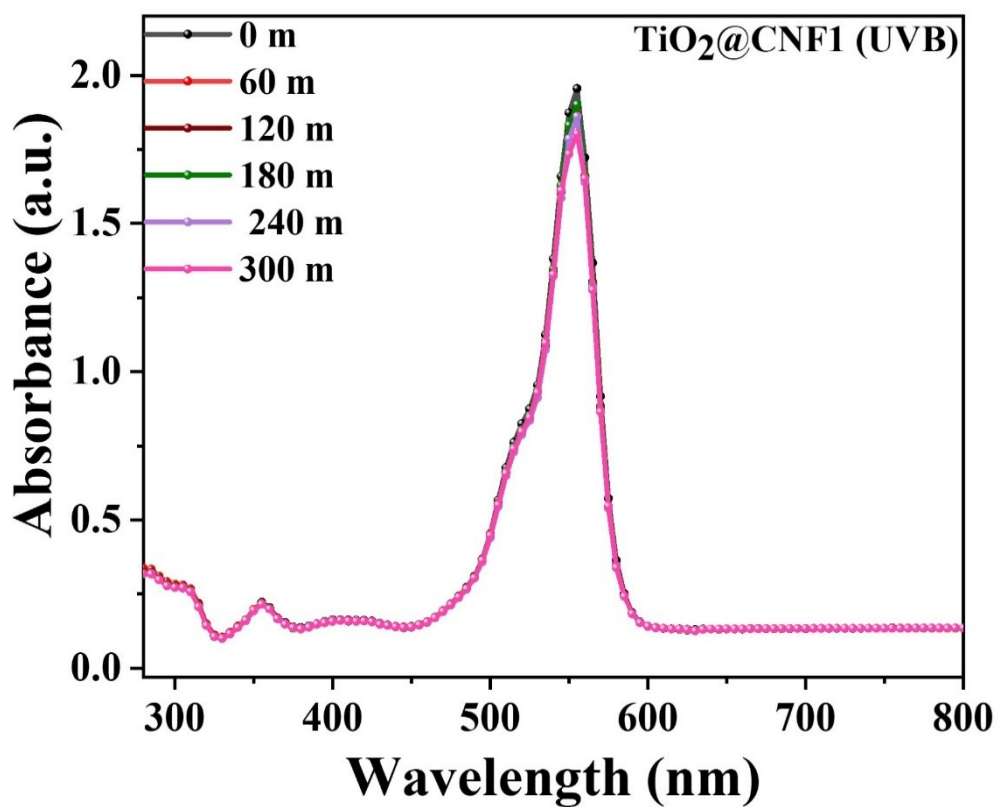


Figure S23. Photocatalysis experiment of TiO₂@CNF1 hybrid for the Rho-B after subjected the UVB illumination for 300 min.

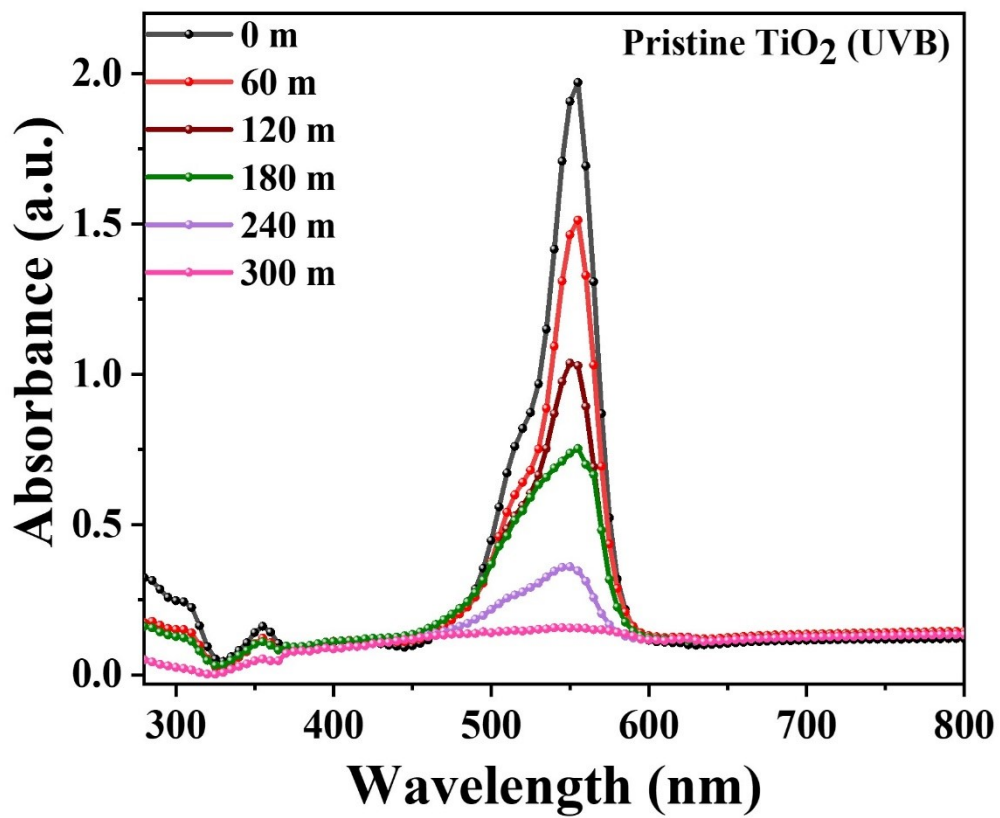


Figure S24. Photocatalysis experiment of pristine TiO₂ for the Rho-B after subjected the UVB illumination for 300 min.