Supporting Information to:

**Polysaccharide Nanocomposites in Water Treatment: A Review**

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**Table S1.** PSA-based nanocomposites in a brief view, their preparation methods and their applications.

| Polysaccharide | Nanoparticle | Preparation methods | Application | Refs. |
| --- | --- | --- | --- | --- |
| Alginate | Silver | Microemulsion method | Antimicrobial and antibiofilm | [1] |
| TiO2 | Casting-solvent evaporation | Food packaging | [2] |
| GO | Freeze drying | Bone tissue engineering | [3] |
| Zeolite | Hydrogel | Controlled-release medications | [4] |
| Polyethyleneimine/silver | Hydrogel | Photocatalytic degradation | [5] |
| Cellulose | ZnO | *In-situ* | Dye removal | [6] |
| ZIF-67 | *In-situ* | Antibacterial | [7] |
| AgNps@CFs@HKUST-1 | *In-situ* | Antibacterial | [8] |
| @ZIF-8 filter | *In-situ* growth | Filtration and gas adsorption | [9] |
| Nano silver chloride | Coprecipitation method | Dye removal | [10] |
| Chitosan/Chitin | melanin-like | Spontaneous oxidation | Active food and biomedical packaging | [11] |
| Cu3BTC2/Chitin | *In-situ* | Air filtration | [12] |
| Bio–MOF | Coating | Drug release | [13] |
| Cu-BTTri | *In-situ* | Nitric oxide (NO) release | [14] |
| Zinc oxide nanobeads | A green technique using the Musa X paradisiaca | Photocatalytic degradation | [15] |
| Chitin and chitosan nano hydroxyapatite composite | Precipitation method | Removal of copper (II) | [16] |
| Starch | Adjusted nanoscale form of zero-valent iron | Liquid reduction method | Dye removal | [17] |
| Carboxymethylated starch nanocrystals | acid hydrolysis | Drug delivery | [18] |
| Xanthan gum & acrylic acid | Magnesium oxide | Radiation-induced copolymerization and crosslinking technique | Drug delivery system | [19] |

**Table S2.** Types of PSA nanocomposites served in adsorption processes.

| Polysaccharide | Nanoparticle | Qmax (mg.g-1) | Pollutants | Refs. |
| --- | --- | --- | --- | --- |
| Sodium alginate | Graphene oxide | 100.3 | Crystal violet | [20] |
| Sodium alginate | Clay | 112 | Cd2+ | [21] |
| Phosphate | 105 |
| Activated Charcoal | 137 |
| Alginate | Cobalt ferrite | 6.75 | Reactive red 195 | [22] |
| 5.95 | Reactive yellow 145 |
| Carboxymethyl chitosan & sodium alginate | Graphene oxide@Fe3O4 | 55.96 | Cu2+ | [23] |
| 86.28 | Cd2+ |
| 189.04 | Pb2+ |
| Chitin | Clay | 156.7 | MB | [24] |
| Chitin | Calcium carbonate (CaCO3) | 266.4 | Congo Red | [25] |
| Chitin | Bentonite | 67 | Trimethoprim | [26] |
| Chitosan | Fe3O4 | 20.41 | MB | [27] |
| Chitosan | Silica/ZnO | 293.3 | MB | [28] |
| Chitosan | TiO2 | 210 | Reactive red 120 | [29] |
| Chitosan | Graphene oxide & Fe3O4 | 111.11 | Cu(II) | [30] |
| 142.85 | Cr(VI) |
| Chitosan & carboxymethyl cellulose | Graphene oxide | 655.98 | MB | [31] |
| 404.52 | Methyl orange |
| Cellulose | ZnO | 64.93 | MB | [6] |
| Carboxymethyl cellulose/polyacrylic acid | Fe3O4-C30B | 1081.6 | MB | [32] |
| Gellan gum | MgO | 92.5 | Cationic malachite green dye | [33] |
| Starch & PEG-polyacrylic acid | Ag | 182.53 | Hg2+ | [34] |
| Starch & clinoptilolite | CoFe2O4 | 32.84 | MB dye | [35] |
| 31.81 | Methyl violet dye |
| 31.15 | Crystal violet dye |
| Xanthan gum & polyacrylic acid | Hydroxyapatite | 130 | MB | [36] |
| Xanthan gum | SiO2 | 588.2 | Malachite green | [37] |
| Xanthan  gum-cl-Dimethyl acrylamide | Silica | 150.7 | Cd2+ | [38] |
| Grafted xanthan gum with polyvinylimidazole | Montmorillonite | 909.1 | Malachite green | [39] |
| Xanthan gum & sodium alginate | Ctyltrimethyl ammonium bromide modified montmorillonite | 769.23 | Malachite green | [40] |
| Xanthan gum | Fe/Zr | 132.3 mg/g | Sc | [41] | |
| 14.01 mg/g | Nd |
| 18.15 mg/g | Tm |
| 25.73 mg/g | Yb |

Table S3. Types of PSA nanocomposites used in membrane-based processes, in view of type of membrane, nanoparticle, pollutant, and removal percent.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Polysaccharide | Nanoparticle | Type of membrane | Removal of pollutants | Pollutants | Refs. |
| Calcium alginate | Carboxylate titanium dioxide | Nanofiltration | 98.4% | Brilliant blue G250 | [42] |
| 96.8% | Direct black 38 |
| 95.9% | Congo red |
| Calcium alginate | Carboxylate titanium dioxide | Ultrafiltration | 5.33 mg/g | Congo red | [43] |
| Alginate | Graphene oxide | Nanofiltration | 118.6 mg/g | Cr (III) | [44] |
| 327.9 mg/g | Pb (II) |
| Cellulose | Alpha‑zirconium phosphate | Microfiltration | 97% | Cu (II) | [45] |
| 98% | Zn (II) |
| 99.5% | Ni (II) |
| 91.5% | Pb (II) |
| Cellulose | Graphene oxide | Nanofiltration | 86.4 mg/g | Rhodamine B | [46] |
| Chitosan | Iron oxide | Nanofiltration | 96% | MB | [47] |
| 98% | Reactive orange |
| Chitosan | Graphene oxide | Nanofiltration | 889 mg/g | Pb2+ | [48] |
| Polyvinyl alcohol/starch | ZSM-5 zeolite | Nanofiltration | 2.17 mg/g | Eriochrome black T | [49] |
| Xanthan gum | Montmorillonite | Nanofiltration | 99.99% (909.1 mg/g) | Malachite green (MG) dye | [50] |

**Table S4.** Types of PSA nanocomposites in photocatalysis

| Polysaccharide | Nanoparticle | Degradation efficiency | Pollutants | Irradiation/Bacteria | Ref. |
| --- | --- | --- | --- | --- | --- |
| Alginate | Fe3O4 & TiO2 | 98%  30 min | Tetracycline | UV-C irradiation,  -- | [51] |
| Alginate | Zr(IV) phosphate | 97.45%, 5 h | MB | Solar irradiation,  *E. coli* | [52] |
| Alginate | Zr(IV) phosphate | 92.43%, 5 h | Fast green | Solar irradiation,  *E. coli* | [52] |
| Alginate  & carboxymethyl cellulose | ZnO | 90.12%, 110 min | Congo Red | Solar irradiation,  - | [53] |
| Cellulose | Zinc sulphide | 75.62% | Phenol | Visible light irradiation,  *E. coli* | [54] |
| Cellulose | Cr2O3 | 99.65%, 40 min | Crystal violet | UV irradiation,  *E. coli* & *P. aeruginosa* & *S. aurous* & *S. pyogenes* | [55] |
| Cellulose | ZnO | 91%, 2 h | Methyl orange | UV-irradiation,  *S. aureus* & *Bacillus subtilis* | [56] |
| Chitin-cl-polyitaconic acid-co-acrylamide | zirconium tungstate | 92.66%, 2h | Fast sulphon black | UV-irradiation | [57] |
| Chitin | TiO2/ZnO | 61%, 4 h | Methyl orange | UV irradiation | [58] |
| Chitosan | ZnO | 78%, 2 h | MB | UV irradiation | [59] |
| Chitosan | ZnO | 57.90%,  110 minutes | Fast Green dye | Solar light  - | [60] |
| Chitosan | ZnO | 71.45%,  110 minutes | Fast Green dye | UV irradiation  - | [60] |
| Chitosan | TiO2 | 63.58%, 2 h | Methyl orange | Visible light | [61] |
| Chitosan | Silver sulfide /nickel titanate (NiTiO3) | 100%, 40 min | Metronidazole | Visible light irradiation,  *S. pneumonia* & *E. coli* | [62] |
| Chitosan-polyvinyl alcohol | Silver-manganese disulfide (Ag-MnS2) | 97.29%, 30 min | Malachite green | Visible light irradiation,  *E. coli* & *S. aureus* | [63] |
| Polyvinyl alcohol-chitosan | Copper monosulfide (CuS) | 96.5%, 1 h | Malachite green | UV-irradiation,  *E. coli* & *P. syringae* & *S. aureus* & *S. pneumoniae* | [64] |
| Starch-*g*-polyacrylic acid | ZnSe quantum dots | Dark: 94.5%  Visible: 95.5%  UV light: 98.5% | Crystal violet | Visible & ultraviolet light,  *E. coli* | [65] |
| Starch & polyalginic acid-clacrylamide | Fe/Zn | 91%, 5 h | Malachite green | Solar irradiation | [66] |
| Starch & polyalginic acid-clacrylamide | Fe/Zn | 82%  5 h | Fast green | Solar irradiation | [66] |

**Table S5.** Pollutant removal from wastewater using various strategies and different types of PSA nanocomposites.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Wastewater treatment technique** | **Cost-effectiveness** | **Technical maturity** | **Environment-friendliness** | **Performance- efficiency** | **Automaticity** | **Refs.** |
| Adsorption | Very good | Good | Good | Very Good | Poor | [67] |
| Membrane | Fair | Very good | Good | Good | Poor | [68] |
| Photocatalytic | Fair | Poor | Very good | Fair | Poor | [69] |

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