

# Facile Preparation of GO-CuO Containing Chitosan/PVA Electrospun mats for Adsorption of Heavy Metals and Dyes from Tannery Effluents

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## Statement of Problems

Industrial waste is increasing due to fast industrialization and exponential development in the demand for industrial products, and it is contaminating the environment incurably. Among all the industrial wastes, tannery effluents are considered to be a major contributor to contaminants to the environment.



Industrial discharges are rich in poisonous chemicals, dyes, and heavy metals. These produce unpredictable consequences, affect environmental safety, decrease the quality of life, danger and so organic dye in wastewater that may inevitably also lead to death.

## Motivation

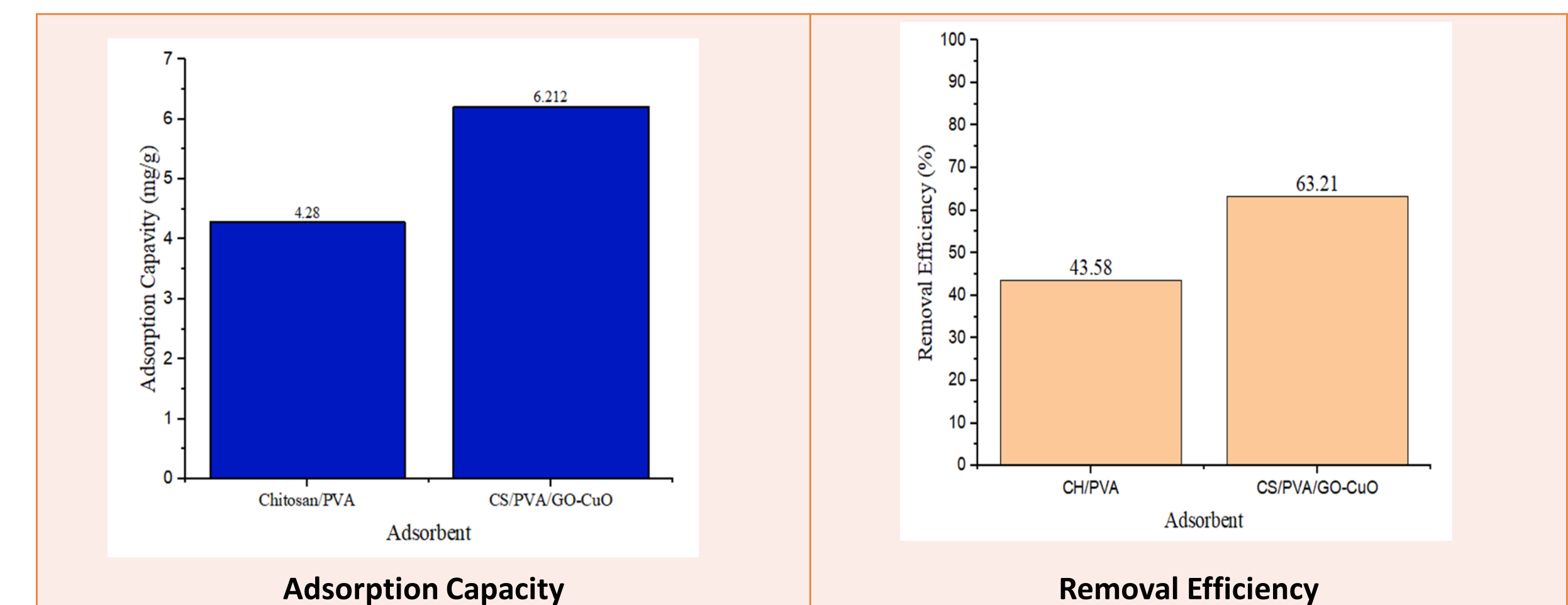
- ✓ To synthesize Graphene oxide (GO) by using the Hummers method, green synthesis of CuO nanoparticles, chemical synthesis of GO-CuO nanocomposite, synthesis of Chitosan by utilizing waste shrimp shells, preparation of chitosan/PVA electrospun nanofibre;
- ✓ To set up a satisfactory electrospinning method, which incorporates finding an appropriate electrospinning solution (nature of the solvent, solvent concentration, polymer concentration) and to figure out flawless parameters of processing (voltage, needle tip-to-collector distance, flow rate);
- ✓ To construct a stable adsorbent with GO-based CuO nanoparticles and Chitosan/PVA electrospun nanofibres with their functional groups;
- ✓ To characterize the synthesized GO, CuO NPs, GO-CuO NCs, Chitosan/PVA electrospun nanofibre and Go-based CuO NPs and Chitosan/PVA electrospun nanofibre composites using Fourier Transformed Infrared Spectroscopy (FT-IR), X-ray Diffraction (XRD), Thermo Gravimetric Analysis (TGA), Atomic Absorption Spectroscopy (AAS);

The motivation behind this work was the development of a new robust adsorbent based on the incorporation of GO-CuO Nanocomposites into Chitosan/PVA electrospun fibrous mat.

## Preparation of GO-CuO

- In the first step, 100 mg of as prepared GO was dispersed in distilled water (50 ml) and ultrasonicated for 1 h to form a homogeneous dispersion
- Then, copper nitrate (0.906 g) and trisodium citrate (0.55 g) were dissolved in 20 ml and 5 ml of distilled water, respectively, to get the respective solutions
- These prepared solutions were gradually added to the as prepared GO solution, and were ultrasonicated for half an hour
- Later, 2 M NaOH solution (10 ml) was prepared and the drop wise addition of this solution was accomplished until the pH of the mixture reached to 10
- The whole solution was further ultrasonicated for 1 h at room temperature, and naturally a dark brown solution was obtained. This obtained colloidal suspension was centrifuged at 5000 rpm and the resulted precipitate thus separated out which was washed thoroughly using distilled water and dried at 80 °C for 12 h. Finally, the obtained nanostructured material was calcined at 300 °C for 2 h

## Adsorption capacity and removal efficiency of methylene blue



## Strategies to mitigate industrial water pollution

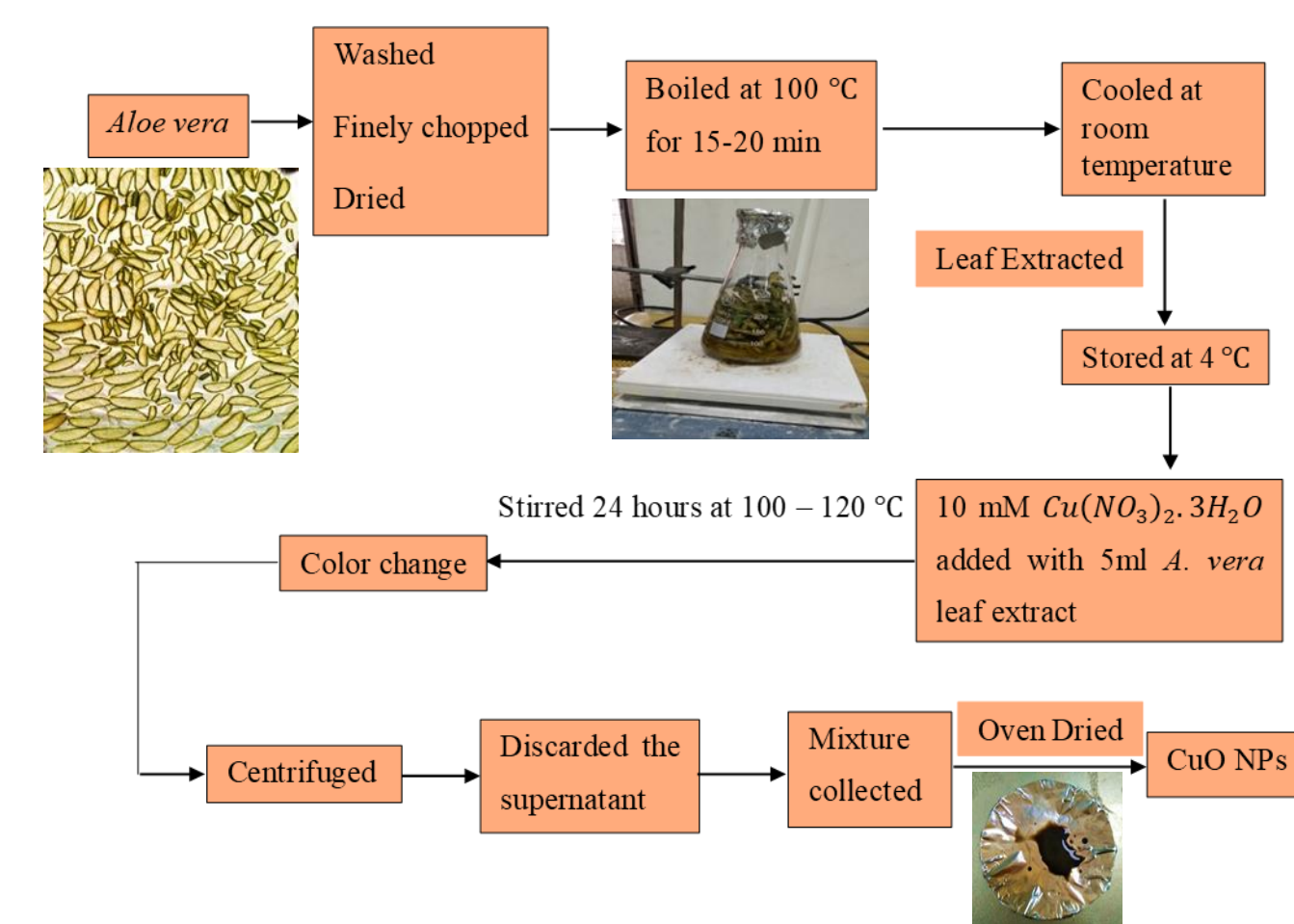
One of the most common methods of controlling these pollutants (heavy metals and dyes) at low concentration is the adsorption technique, which can be considered as an operational procedure because of its simplicity and economic feasibility.

Adsorption of heavy metals through nanofibrous mat has pulled in enormous consideration due to its attractive properties, for example, huge surface zone, high surface to volume proportion, little size, and so on. They show great adsorption, strength, and selectivity.

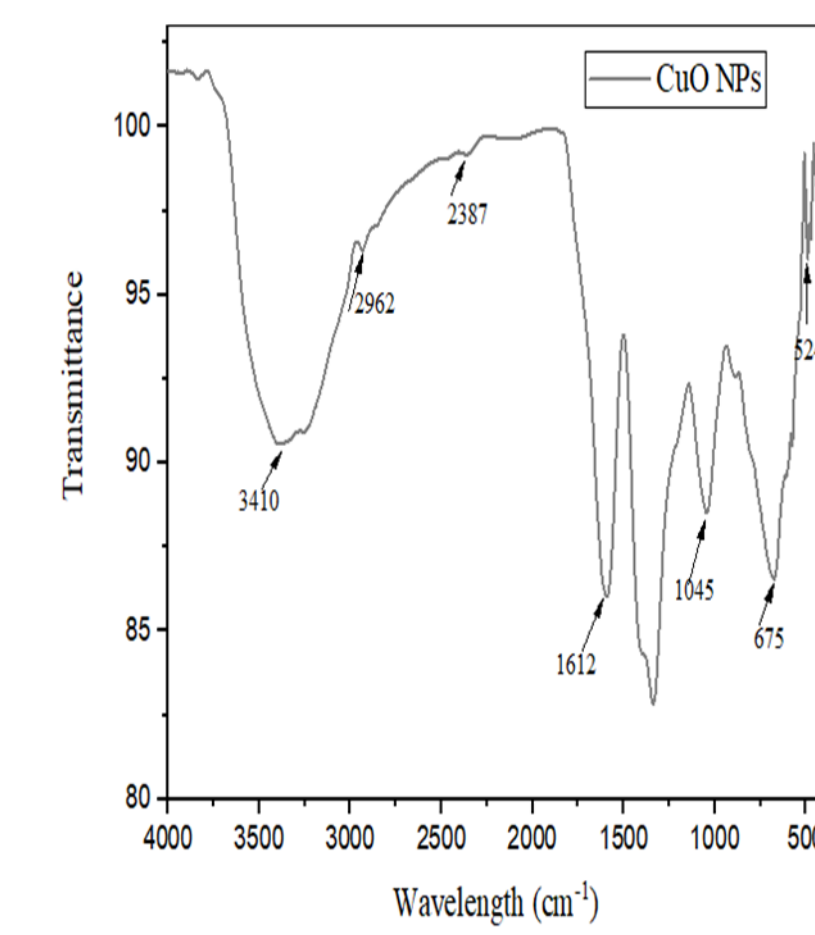
In recent years, electrospun nano-structured membranes for the removal of heavy metal ions have been manufactured and become one of the most important subjects of membrane science. Electrospun nanofibrous layers show exceptional characteristics, like low fiber diameter, expansive surface zone, and high porosity.

Chitosan/PVA/Metal oxide-GO nanofibrous mat delineates better outcomes when contrasted with GO, indicating the convenience of composites for heavy metals and dye adsorption from wastewater. The addition of graphene oxide to the standard adsorbents, such as chitosan, extended their compressive strength and made them a capable and biodegradable stone landmark.

## Green synthesis of copper oxide nanoparticles

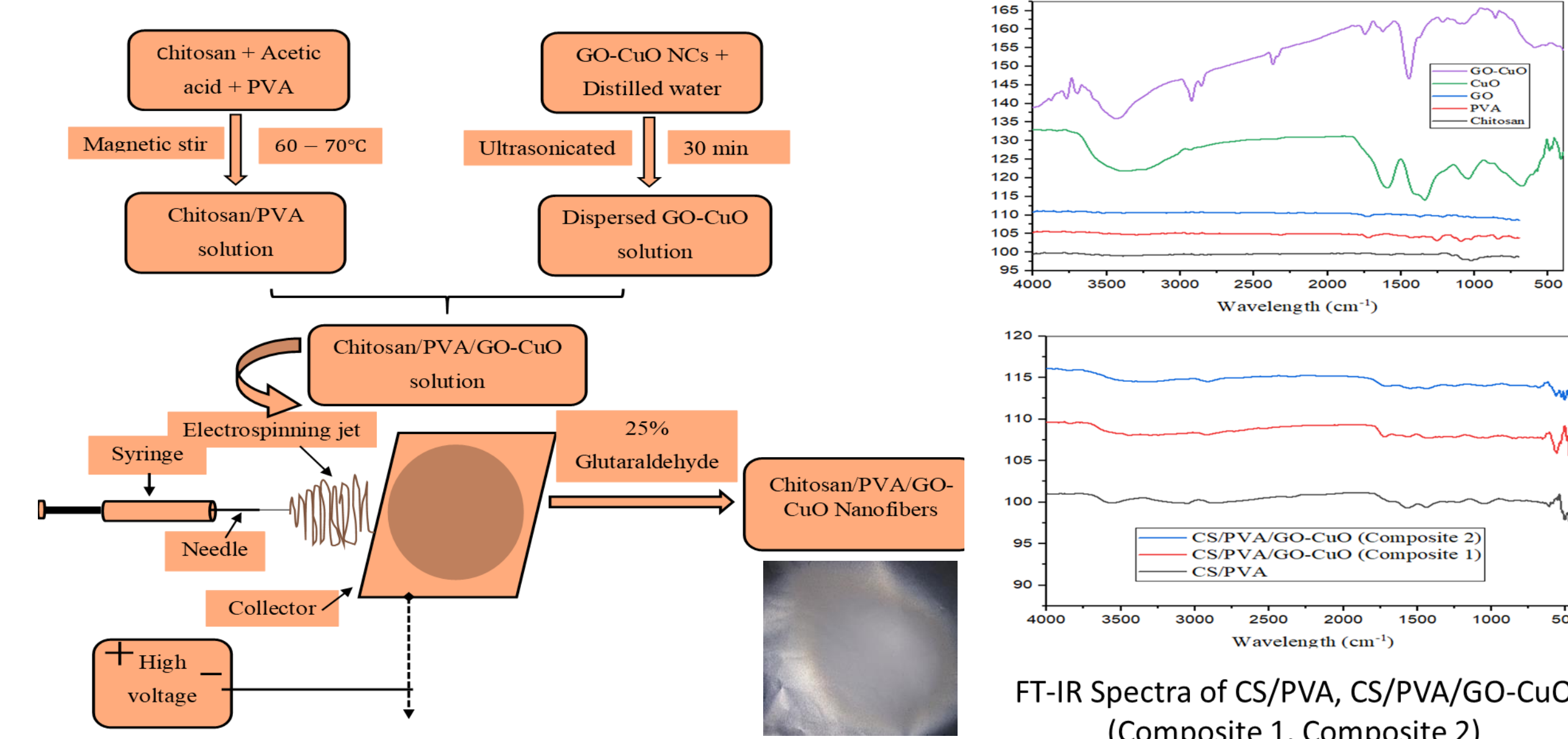


Flow diagram of green synthesized copper oxide nanoparticles preparation



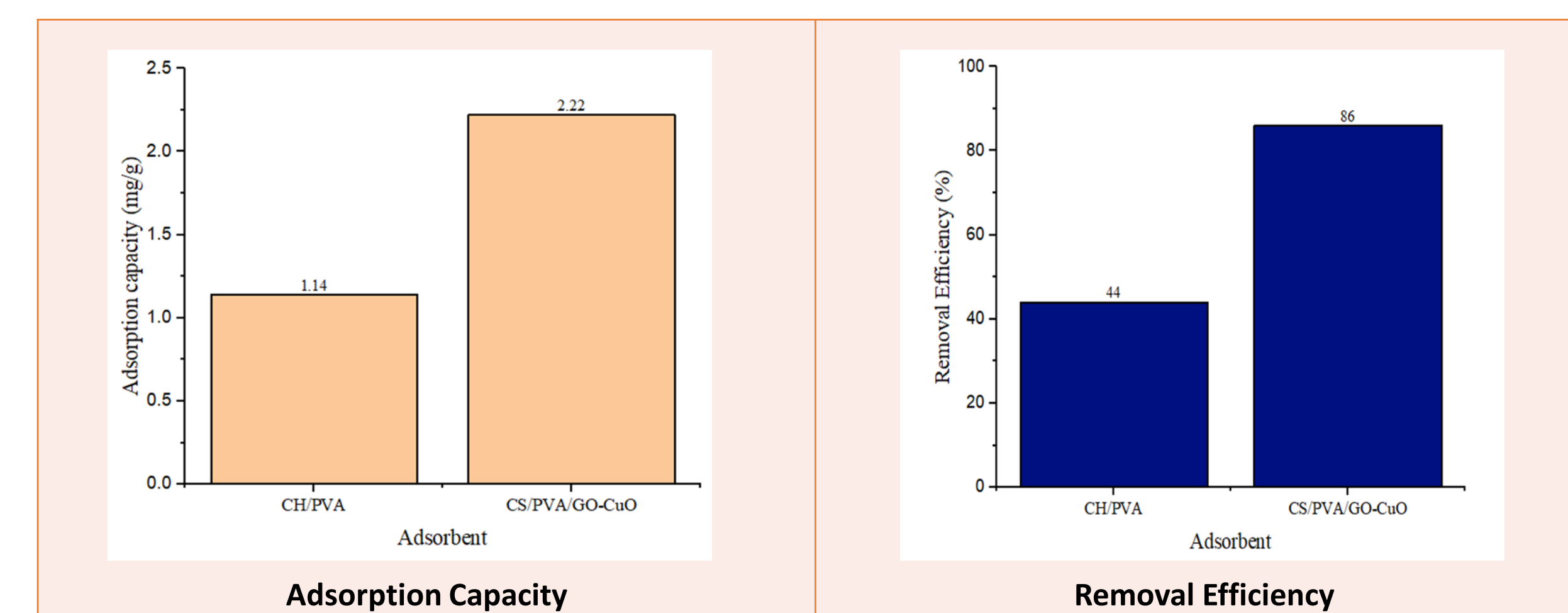
FT-IR Analysis

## Preparation of chitosan/PVA/GO-CuO nanofibrous mat by electrospinning technique



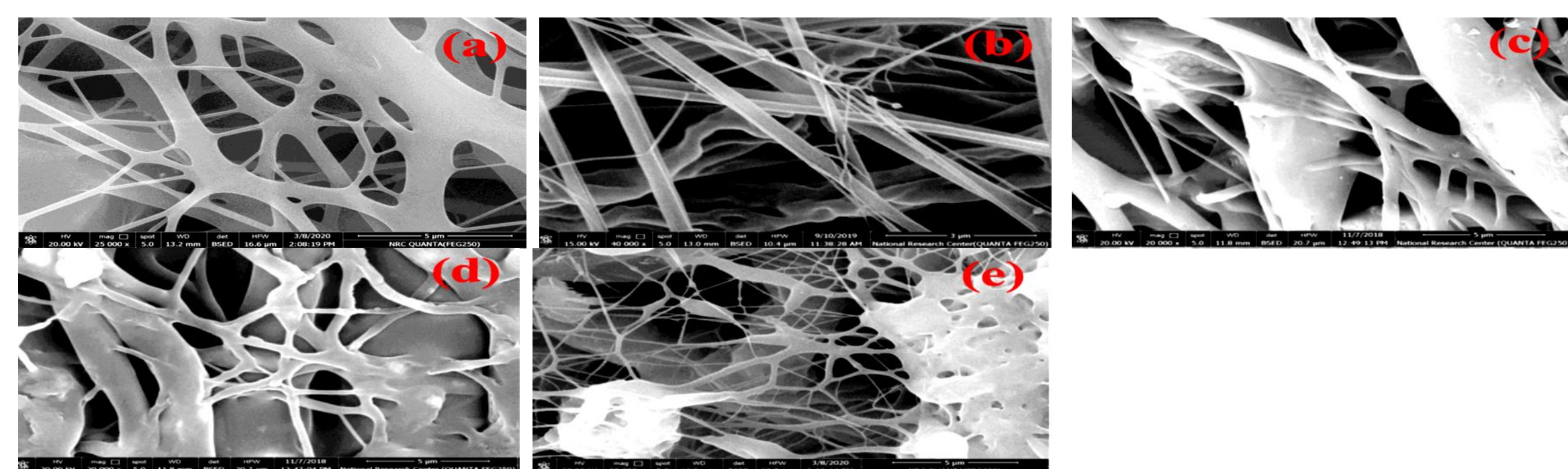
FT-IR Spectra of CS/PVA, CS/PVA/GO-CuO (Composite 1, Composite 2)

## Adsorption capacity and removal efficiency of lead



## Strategies to mitigate industrial water pollution

In a study, electrospun nanofibrous membranes of cellulose acetate containing fillers of graphene oxide (GO), magnetite nanoparticles (MNPs) or hydroxyapatite (HAP) were fabricated. The as-synthesized membranes were formed as a non-oriented network with diameters ranging from 0.11-0.35 µm and 0.66-1.23 µm, 0.14-0.33 µm and 0.6-0.89 µm, 0.17-0.37 µm and 0.91-4.57 µm and 0.18-0.53 µm and 1.18-2.1 µm and 0.11-0.29 µm for CA, GO@CA, MNPs@CA, HAP@CA and GO/MNPs/HAP@CA, respectively.

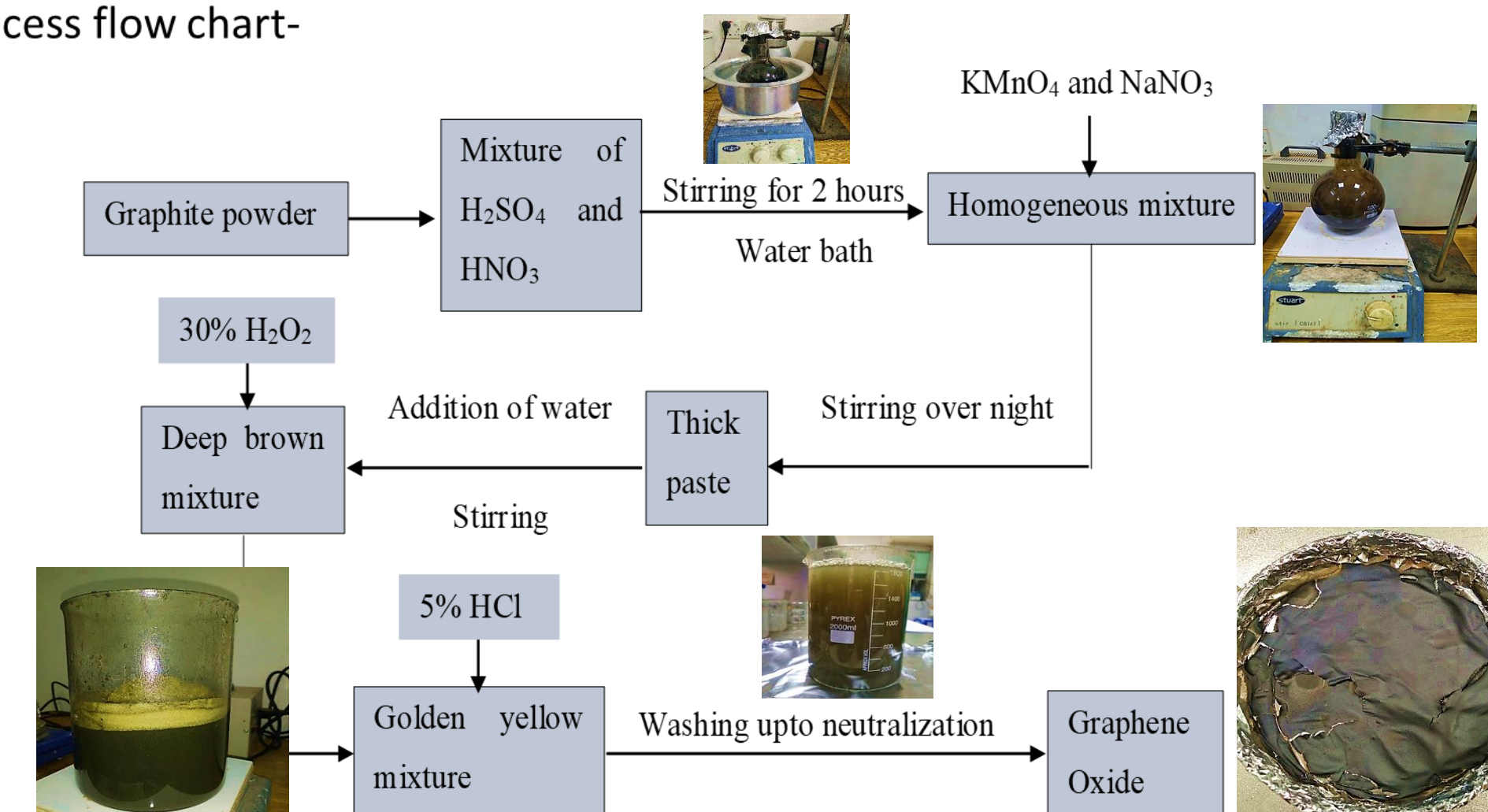


FESEM micrographs of nanofibrous membranes of CA; (a) pristine CA, (b) GO@CA, (c) MNPs@CA, (d) HAP@CA and (e) GO/MNPs/HAP@CA.

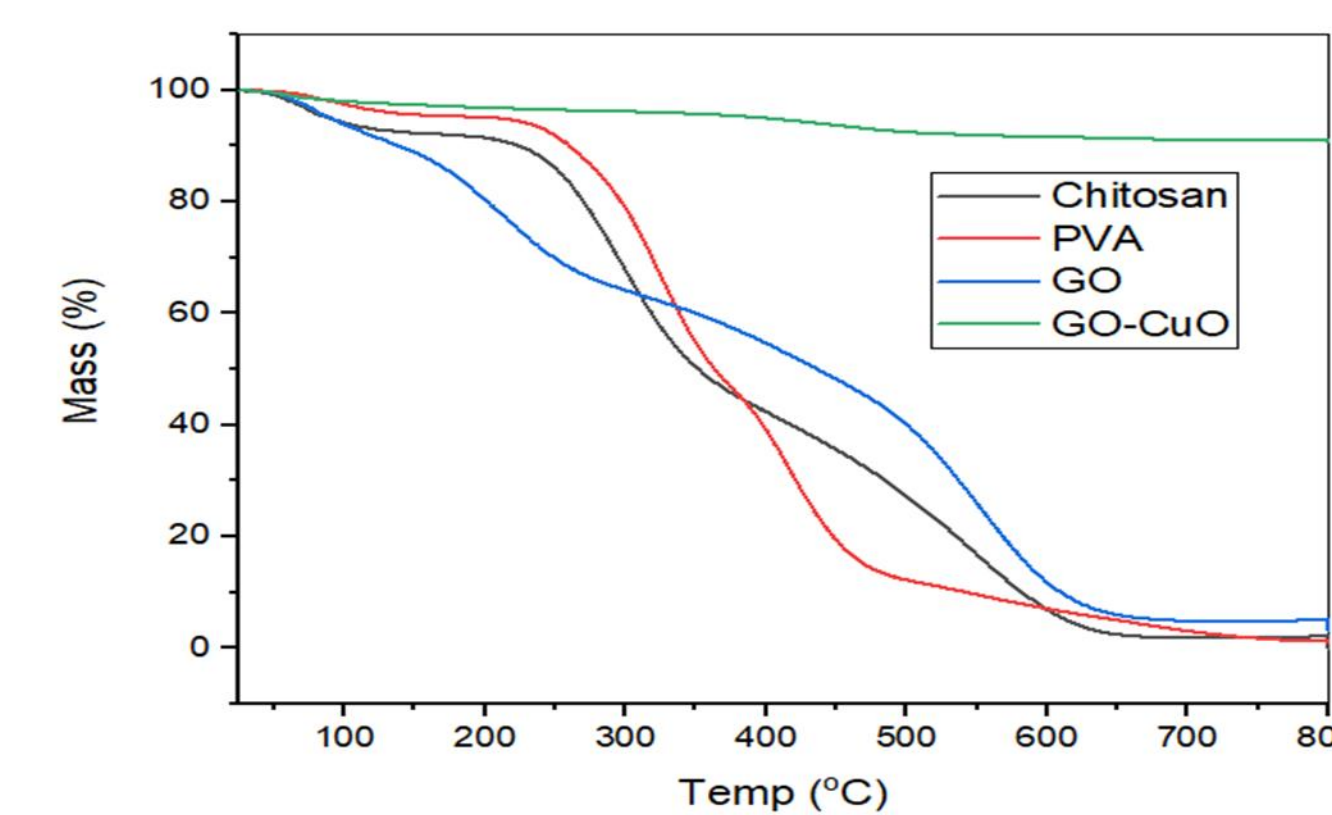
R. Al-Wafi et al. Journal of Water Process Engineering 38 (2020) 101543.

## Synthesis of Graphene oxide (GO)

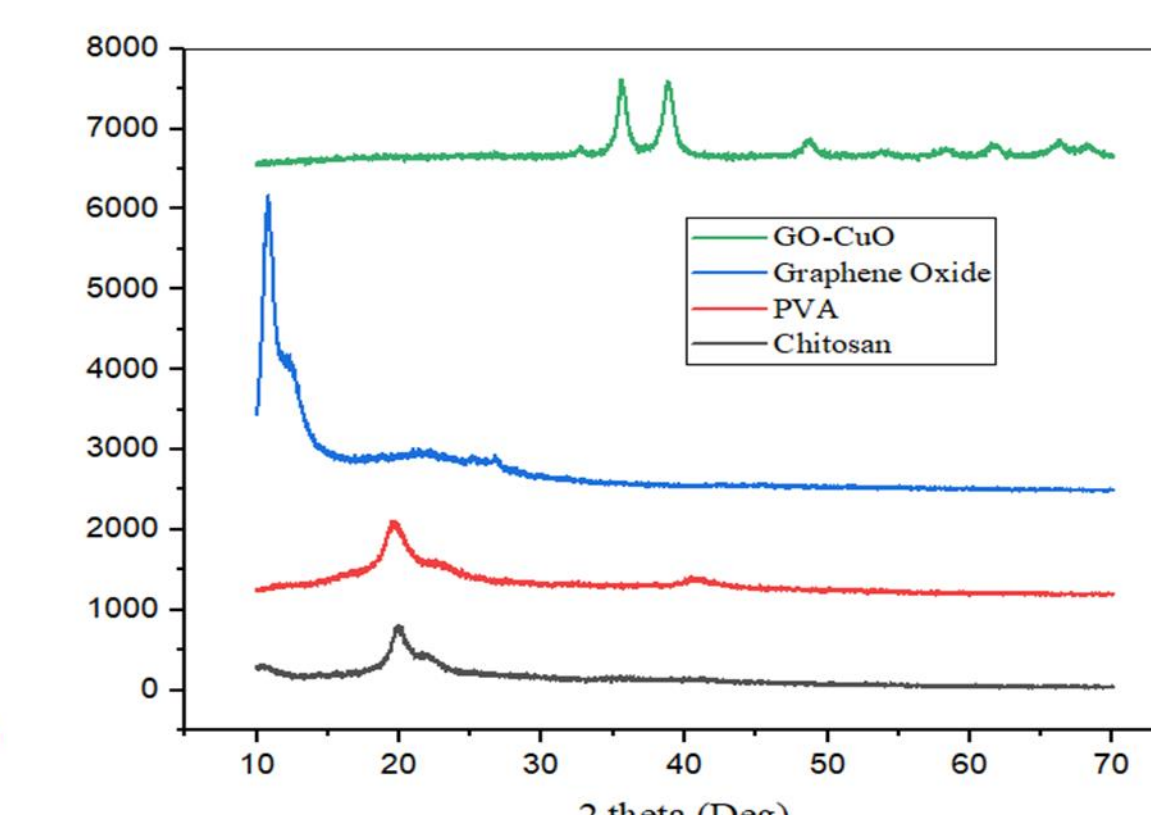
Graphene oxide (GO) was produced using modified hummers method from pure graphite powder. The process flow chart-



## Characterization of chitosan/PVA/GO-CuO nanofibrous mat



TGA Diagram of (a) Chitosan, (b) PVA, (c) GO, and (d) GO-CuO



XRD Pattern of (a) Chitosan, (b) PVA, (c) Graphene Oxide, and (d) GO-CuO NCs

## Conclusions

The nanofibrous mat of Chitosan/PVA/GO-CuO acts as a promising adsorbent to remove Pb (II) ions and methylene blue dye from standard solution.

The adsorption capacity of methylene blue and Pb<sup>2+</sup> is better for the prepared composite than chitosan/PVA electrospun nanofiber. Incorporation of GO-CuO in the Chitosan/PVA fiber improves the adsorption capacity of the dye and heavy metal.

The removal efficiency of MB was 63.21% and for Pb (II) the efficiency was 86%.