


BIO ADSORBENT FOR ENVIRONMENTAL APPLICATIONS

by
Deepak Kumar Mandal
(170122014)



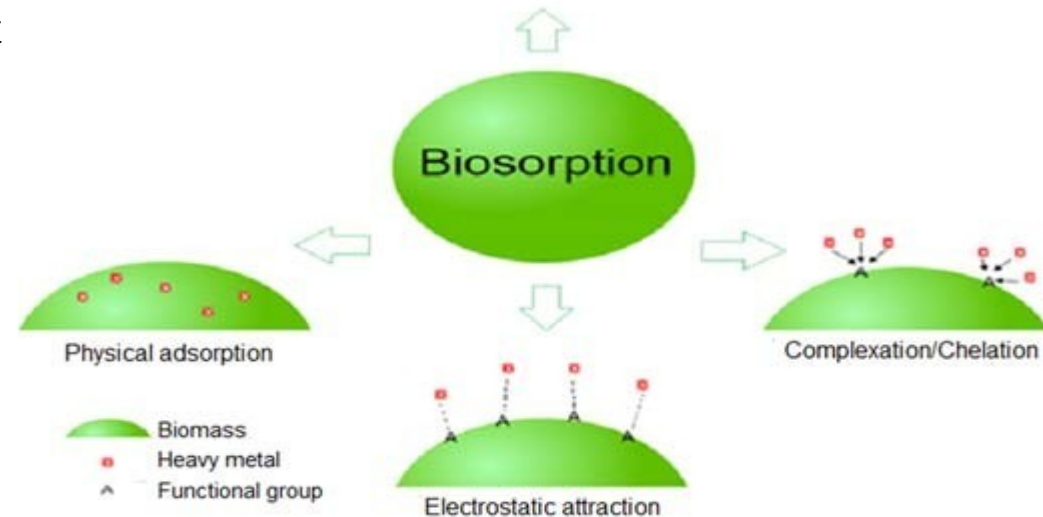
Contents:

- A brief introduction to the contents (Bio Adsorbent for Environmental Applications) that is going to be present.
- Recent Advances to promote Bio Adsorbent for Environmental Applications.
 - Bio adsorbent for the adsorption of toxic heavy metal ions
 - Bio adsorbent for the adsorption of toxic dyes molecule
- Conclusion/Summary

- Heavy metals are a toxic pollutant, that commonly present in aqueous solution or waste water through mining activities, petroleum refinery, smelting, metal-manufacturing plants, battery manufacturing, pigment, volcanic emissions, etc.
- Another common pollutant is Dyes, which typically come from the textile industry. Like heavy metals they are also toxic, not biodegradable thus, are dangerous for the health of human as well as the environment.



- Bio adsorption or Biosorption refers to a set of process that involves (may be one or the combination of) physical and chemical adsorption, complexation, electrostatic interaction, ion exchange, chelation, coordination, microprecipitation.



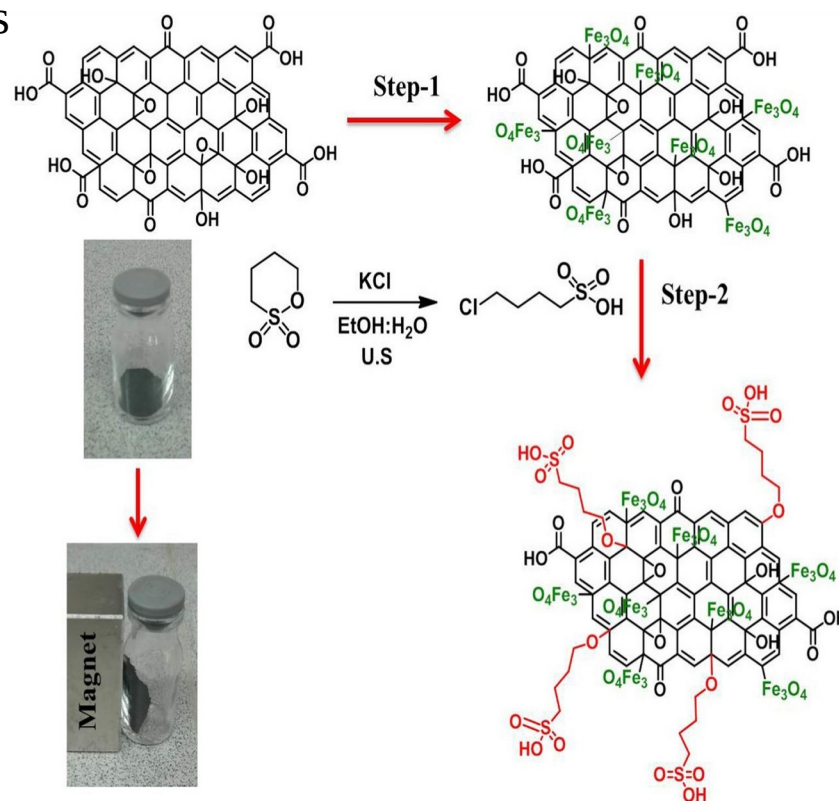
Recent Advances

Bio adsorbent for the adsorption of Heavy metal ions

A modified bio adsorbent which has been prepared by the loading of Fe_3O_4 nano-particles and immobilization of 1,4-butane sultone ($-\text{SO}_3\text{H}$) on the surface of activated carbon.

There are following two steps involved in the synthesis of modified activated carbon-based bio adsorbent:-

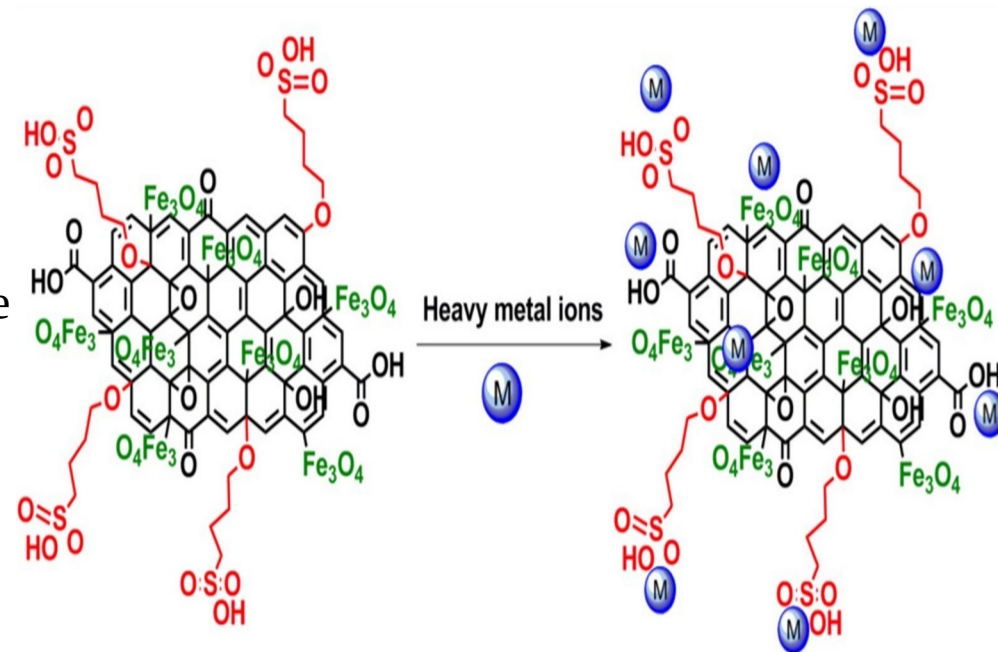
1. The Activated Carbon (AC) is produced from the agriculture wastes. By Supporting Fe_3O_4 nano particles onto activated carbon, we get the modified resulting surface which has a large number of active sites, that can increase the chemical adsorption or chemisorption.
2. Fe_3O_4 nanoparticle activated carbon can be separated by using an external magnet. Further, this is subjected to 1, 4 - butane sultone via ring-opening reaction under mild condition, to enhance the acidic functional groups on the Fe_3O_4 nano-particle activated carbon. That will result into nanocomposite which is termed as Fe_3O_4 NPs@AC@ $\text{C}_4\text{H}_8\text{SO}_3\text{H}$ composites.



(Step 1) synthesis of Fe_3O_4 @AC (Step 2) synthesis of Fe_3O_4 NPs@AC@ $\text{C}_4\text{H}_8\text{SO}_3\text{H}$ composites.

- Here 1, 4 - butane sultone (-SO₃H) is a reagent and strong chelating agent for separation of heavy metals, because it includes sulfur and oxygen atoms that can be strongly combined with metal ions and cause them to be separated.

Mechanism: The heavy metal ions forms complex with the sulfonic acid (-SO₃H), hydroxyl (-OH), and carboxyl (-CO₂H) group presents on the surface of Fe₃O₄ Nps@AC@C₄H₈SO₃H composites.



This modified bio adsorbent can be used for adsorption of heavy metal ions such as Lead: Pb(II), Cadmium: Cd(II), and Arsenic: As(III) from aqueous solutions at an industrial scale.

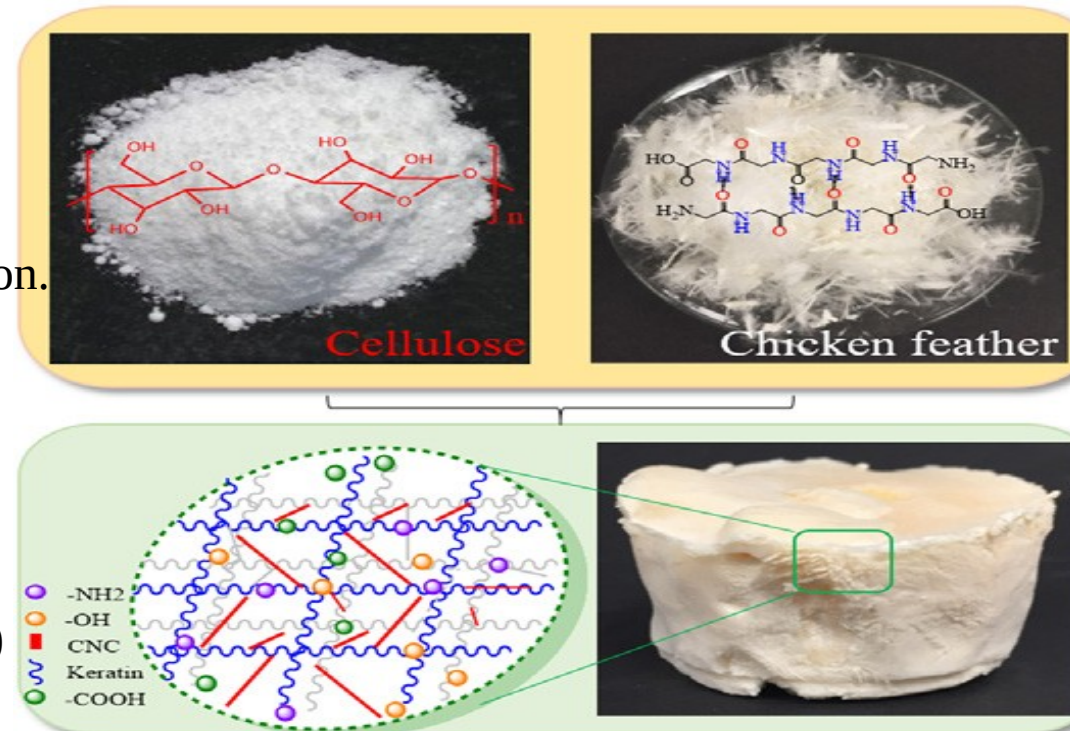
Recent Advances

Bio adsorbent for the adsorption of dyes molecule

Cellulose nano crystal - reinforced keratin bio adsorbent for adsorption of dye molecules from aqueous solution.

There are following steps involved in the preparation of cellulose-keratin based bio adsorbent:-

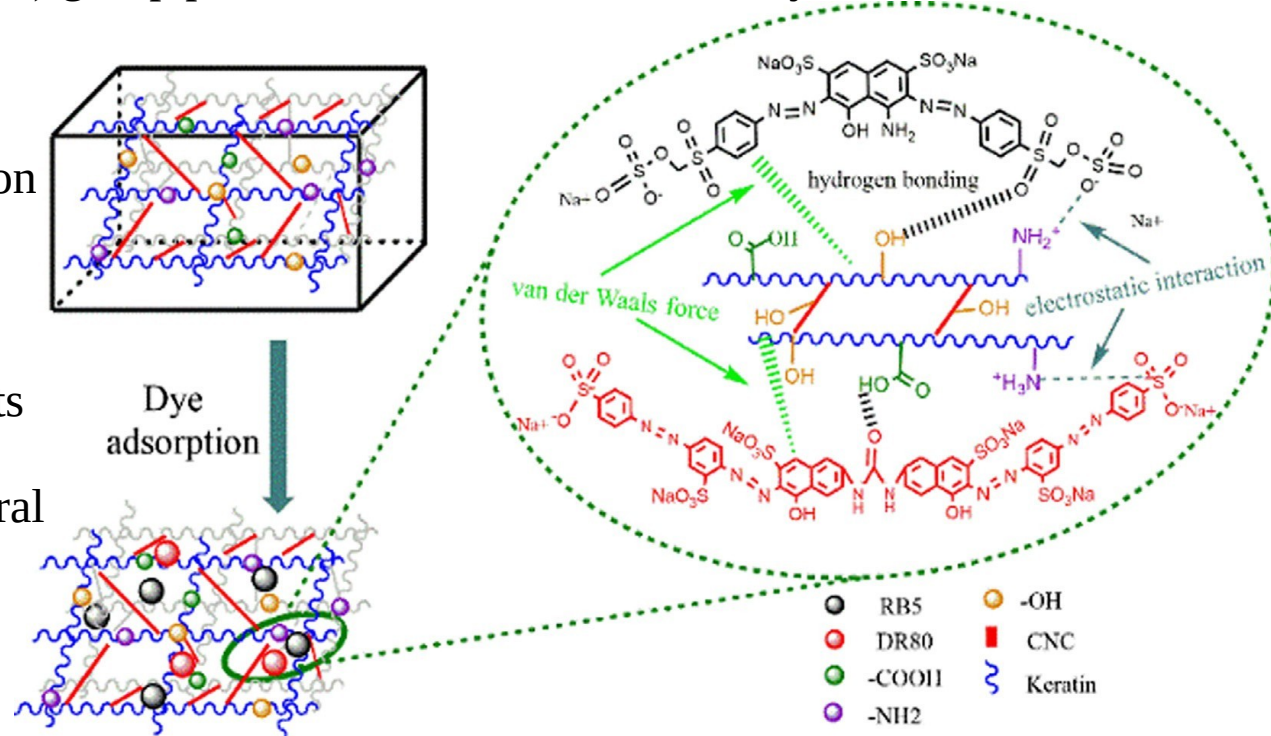
- At first, Keratin solution is prepared from feathers by immersing into urea ($\text{CH}_4\text{N}_2\text{O}$) solution with cysteine ($\text{HO}_2\text{CCHCH}_2\text{SH}$) followed by removal of undissolved feathers. This process is termed as Extraction.
- Cellulose nano-crystal (CNC) is produced by the hydrolysis of cotton fabric with sulfuric acid (H_2SO_4).
- CNC is added into keratin solution by using the ultrasonication process, followed by the addition of Glutaraldehyde ($\text{C}_5\text{H}_8\text{O}_2$) as a crosslinking agent.
- Cellulose nano crystal reinforced keratin adsorbent is fabricated by the freeze-dried process. This process enhances the crosslinking reaction. Thus, we get the water stable bio adsorbent.



Mechanism: The separation of dye molecules from aqueous solution takes place due to the various interaction between the dye molecule and the functional groups like amino ($-\text{NH}_2$), hydroxyl ($-\text{OH}$), and carboxyl ($-\text{COOH}$) group presents in the cellulose nanocrystal-reinforced keratin bio adsorbent:-

- Formation of hydrogen bonds
- Van der waals forces of interaction
- Electrostatic force of interaction

- Here, Cellulose Nano-Crystal acts as a nano-filler to provide the dimensional stability and structural integrity to the bio adsorbent.



This bio adsorbent is used for adsorption of dyes such as Reactive Black 5 ($\text{C}_{26}\text{H}_{21}\text{N}_5\text{Na}_4\text{O}_{19}\text{S}_6$, RB5) and Direct Red 80 ($\text{C}_{45}\text{H}_{26}\text{N}_{10}\text{Na}_6\text{O}_{21}\text{S}_6$, DR80) from aqueous solution or wastewater.

The Best part here is -

Apart from having a high adsorption capacity, these bio adsorbent shows advantages such as green synthesis, recyclization, low cost, and more importantly easy separation. So, these bio adsorbents could be a suitable option for adsorption of toxic heavy metal ions and toxic dyes. In this way, we could also put value added to the waste biomass.

That's what makes it sustainable, renewal, and environmentally friendly alternative adsorbent for environmental applications.

Thank you!

