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Research Paper

A Review on Synthesis of Nano Composites for Water Treatment

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ABSTRACT:*Evolution in nanotechnology and nanoscience is the key factor, as proven by recent technological growth. In addition to physics, chemistry, and materials science, nanotechnology also involves other engineering specialties. The field of nanotechnology has grown significantly over the past century. And currently, a wide range of research fields are either directly or indirectly related to nanotechnology. Now a days the main threat will be a lack of water to the millions of members of the human race living in the future. It is critical to create dependable methods for effectively recycling wastewater as every industrial sector demands access to clean water resources. The threat of water contamination has an everyday impact on the health of people, animals, and plants in their immediate environment. Significant attempts have been made to acquire various methods to rule out these pollutants(dyes) in order to address the issue of water pollution. The removal of contaminants from wastewater using nano-sized materials with a high surface area and improved surface reactivity is one such promising method. This work provides a comprehensive understanding of nanomaterials and their use in eliminating dyes from wastewater.*
KEYWORDS: *Nano materials, synthesis, Characterization, Dyes*

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I. INTRODUCTION

Over the past century, the field of nanotechnology has greatly prospered. And today, nanotechnology is a major topic in a wide variety of study fields. The development, synthesis, characterization, and use of materials and devices by altering their size and shape at the nanoscale can be summed up as nanotechnology. Nano is used as a keyword in every field, including product promotion. Traditional physical, chemical, and biological methods (aerobic/anaerobic degradation, enzyme treatment), as well as screening, sedimentation, skimming, and electrochemical processes, were used to treat those contaminated waters; however, these approaches are frequently viewed as less effective for achieving water quality standards Nanotechnology is thought of as a developing field that offers an alternative and the best technology to effectively eliminate the contaminants.

II. TYPES OF NANO MATERIALS

2.1Based on dimensionality:
(1) Zero-dimensional nanomaterials (0-D): These are nanoscale materials in which all three dimensions are zero. This category will include nanoparticles.
(2) One-dimensional nanomaterial (1-D): This has only one dimension that falls into the nanoscale range, and the other two dimensions are outside of this range. Nanowires, nanorods, and nanotubes belong to this class.
(3) Two-dimensional nanomaterials (2-D): Any two dimensions fall within the nanoscale and the final dimension is outside of it. Nano coatings, nanolayers, and nanofilms fall under this category.
(4) Three-dimensional or bulk nanomaterials (3-D): These nanomaterials do not fit into the nanoscale range in any dimension. Accordingly, they are >100 nm scale in three arbitrary dimensions. These comprise nanocomposites, core shells, multiple nanolayers, bundles of nanowires, and bundles of nanoparticles.[1]
2.2. Metal nano particles:
Metal nanostructures are constructed from divalent and trivalent metal ions. Metal nanoparticles can be made in a variety of methods, including chemically and photochemically. Reducing agents change metal ions into metal nanoparticles. Due to their extensive surface area, they can successfully adsorb small molecules. Doping other

metals can change the primary element properties of rare earth metals as well. Their features also change as a result of doping certain components in different constitutions.[1]

2.3. Organic and inorganic:

Inorganic-based nanomaterials are produced using metals or their oxides, such as silicon-based compounds, titanium dioxide, gold, or silver. Inorganic-based nanomaterials are produced using metals or their oxides, such as silicon-based compounds, titanium dioxide, gold, or silver. Except for carbon or inorganic-based sources, organic matter is the source of organic nanomaterials, which can appear as micelles, liposomes, or polymeric particles.

2.4. Basis of origin:

Nanoparticles can be created artificially or naturally (synthetic). Natural nanoparticles are created by biological processes, living things, or human action in the environment. According to their name, synthetic or engineered nanoparticles are nanomaterials created by mechanical processes, intricate systems, or separate or combined chemical, biological, and physical processes.[2]

III. SYNTHESIS OF NANO MATERIALS

The synthesis of nanoparticles can be done by three different approaches. They are as follows.

3.1. Chemical methods:

The chemical method demonstrates a range of bottom-up synthesis techniques for the creation of nanoparticles. This approach works best with gas or liquid phases. This technique allows for the production of pure, regulated particle sizes. There are numerous ways to prepare nanoparticles when using the bottom-up strategy. The size, kind of nanomaterial, simplicity of the process, and qualities of the nanocomposite will be used to choose the best preparation strategy. The various methods of synthesis include the sol-gel method, co-precipitation, hydrothermal approach, solvothermal, sonochemical, pyrolysis, vapour deposition, microemulsion, microwave aided, intercalation, ion-exchange, and reflux.

3.2. physical methods:

Top-down and bottom-up approaches are two categories for the physical methods. In a "top-down" strategy, mechanical milling is used to reduce bigger materials into smaller particles. This method's biggest drawback is how difficult it is to achieve the proper particle size and form. The variation of the magnetic properties of the milled samples is evident when compared to regular particles of the same size because the milling procedure caused flaws in the lattice parameters to form. Nanoparticles are condensed in the "bottom-up" manner in either the liquid or gaseous phase, where the larger materials are created by the chemical fusion of the smaller ions.

3.3. Biological methods:

The biological technique is straightforward, typically requiring only one step, and environmentally beneficial. In this situation, we can create nanomaterials using microorganisms (Bacteria, Fungi, Algae etc) as well as various plant parts. The biological technique is straightforward, typically requiring only one step, and environmentally beneficial. In this situation, we can create nanomaterials using microorganisms as well as various plant parts.

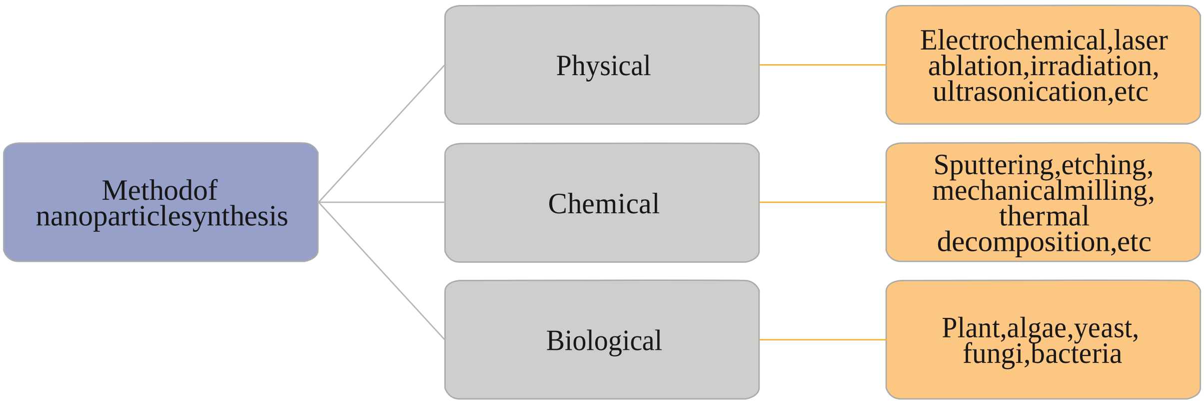

Figure:1. Methods of synthesis of nano materials (2)

IV. CHARACTERIZATION OF NANO MATERIALS

The nanoparticles display many physicochemical properties. They will display distinct properties when their size is changed, even by a very small dimension at the nanoscale. Nanoparticles need to be characterized using a variety of tools in order to look at their qualities. They are the following: Ultraviolet (UV) Spectrophotometer, Fourier Transform Infrared (FT-IR) Spectroscopy, Atomic Force Microscopy (AFM), Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), Vibrating Sample

Magnetometer (VSM), Superconducting Quantum Interference Device (SQUID), X-ray Photoelectron Spectroscopy (XPS), Magnetic Force Micro (TGA).[2]

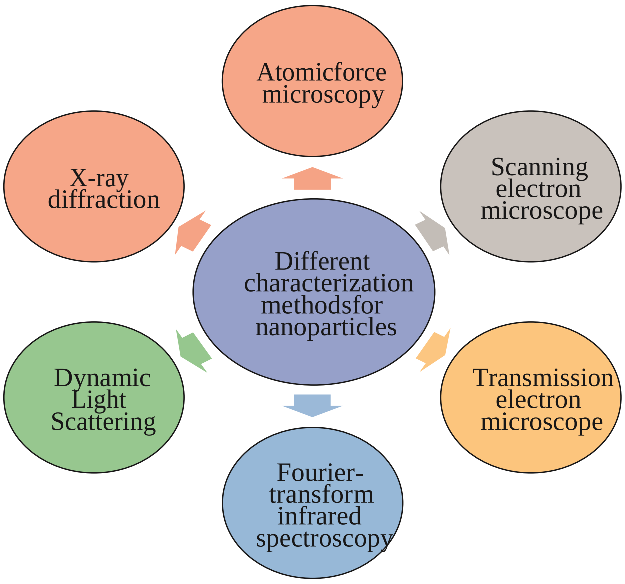

Figure:2. Different characterization techniques (2)

V. LITERATURE REVIEW

The optimal flocculation removal performance for dye and heavy metal wastewaters can be demonstrated by using nano flocculants created by modifying carboxymethyl chitosan (CMCTs) with varied structures. This compound is prepared by chemical precipitation method which is simple and affordable process. The use of CMCTs following transplant modification can enhance the flocculation impact in comparison to their direct addition. Graft modification can increase the stability and specific surface area of conventional flocculants, which helps to raise the treatment's efficacy. With this compound, dye and Cu (II) can be removed with an efficiency of up to 80%. Transmission electron microscopy (TEM), Fourier transform infrared (FT-IR) spectroscopy, X- Photoelectron Spectroscopy (XPS), and particle size analyses were used to characterize this material.[3]

By adding pectin to graphene oxide via a sol-gel process, a special Pc/GO nano-composite was made. The resulting nanocomposite (Pc/GO) was systematically examined using Fourier transform infrared spectroscopy, X-ray diffraction, field emission scanning electron microscopy, high resolution transmission electron microscopy, and X-ray photoelectron spectroscopy. This study looked at the efficiency of the nano-composite for the adsorptive removal of Cr (III) ions and the photocatalytic degradation of organic pollutants, methylene blue (MB), and methyl orange (MO), dyes. In this investigation, samples of graphene oxide that had been doped with various amounts of pectin were created. In this study, samples of graphene oxide were made and doped with varied concentrations of pectin. The Pc/GO nano-composite destroyed both cationic and anionic dyes when exposed to UV radiation, according to the plots of dye degradation. The degradation efficiency after 25 minutes of illumination was 98% for MB and 87.5% for MO after 90 minutes.[4]

$CoFe_2O_4$@MC/ AC was synthesized as a unique magnetic nano-adsorbent in the presence of MC biopolymer for the removal of Reactive Red 198 (RR198) and azo dyes with removal efficiencies of 92.2% and 72%. The microwave approach was employed to create $CoFe_2O_4$@Methyl cellulose (MC)/Activated Carbon (AC) nano-adsorbent in the presence of MC, and the removal efficiency improved with a drop in pH. FTIR, FESEM, EDS, Mapping, Line Scan, XRD, VSM, and BET techniques were used to validate the physical and chemical structure of CoFe2O4@MC/AC. Because of its low cost of biodegradability, biocompatibility, hydrophilicity, and absence of toxicity, methylcellulose (MC) is the most popular commercial cellulose ether. [5]

venidium pentoxide (V2O5) nanoparticles made of multiwalled carbon nano tubes (MWCTS) were used in this study. MWCTs were transformed with V2O5 nanoparticles utilizing the hydrothermal reflux base method. The characteristics of nano adsorbents were discovered using XRD, BET, EDX, FESEM, and FTIR. The maximum adsorption capacity, 50.93 mg/g for methylene blue (MB), was achieved by V2O5/MWCNTs. Following that, they prepared utilizing V2O5: The following CeO2/MWCNTs are used to remove MB from water: MB concentration was 20 mg/L, contact time was 25 min, temperature was 45 °C, and the shaking speed was 240 rpm. With a clearance efficiency of 63.77%, it outperformed earlier trials.[6]

Using a freezing assisted in situ growing technique, a nanoconfined ZIF-8 composite membrane was created in this study on a porous ceramic substrate. When the frozen alumina substrate with the metal ion ice crystal inside of the pores was immersed in a ligand solution, ZIF8 nanoparticles developed inside the substrate's pores as opposed to on its surface. The produced nano-confined ZIF-8 composite membrane displayed effective separation capabilities and stability when utilized to extract dyes from water. With a permeance of 450 kg/m2 hMPa, the rejection of chromium black T from water can reach 99%. Additionally, after 120 hours, there was no discernible change in the membrane's ability to accomplish separation.[7]

VI. CONCLUSIONS

New nanomaterials are being created on a daily basis. In order to be used in many industries, nanomaterials with diverse compositions are also being created. Simple synthesis techniques will result in nanoparticles with the necessary size, shape, and properties that can endure environmental conditions. The development of nanotechnology has led to the emergence of a wide range of innovative nanomaterial-based technologies. In comparison to activated carbon, nanomaterials as adsorbent systems can effectively remove pollutants and have a large surface area for reactions at a relatively small relative weight. As a result, the current review article will give readers a chance to learn more about nanoparticles in general and their role in the removal of contaminants from the waste water.

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