ABSTRACT

Recently nanoparticles have drawn lots of attention due to their size and shape-dependent physical and chemical properties. Nanoparticles can enhance the strength and uniformity of composite materials. Nanocomposites are a new class of material possesses the properties of both inorganic materials and biopolymers. Nanocomposite materials have found a wide range of applications in diverse fields such as constriction, transportation, electronics and other consumer products. Due to nanometer size, the nanocomposite materials possess exclusive characteristics which are not shown by their conventional counterparts.

Currently the researches are focused on the use of nanomaterials to solve the environmental problems. Nano-sized materials are new functional materials, which offer high specific surface area to volume ratio and surface active sites, therefore, can be used as effective adsorbents. Furthermore, nanomaterials have been used in various environmental applications such as photocatalytic degradation of organic dye, removal of heavy metals, pollutant sensing and detection, antibacterial activity etc.

Developing simpler and versatile approach to synthesize the nanomaterial still remains a technical challenge. In the past few decades a large number of synthesis techniques have been adopted worldwide by many researchers.

Keeping in view the above facts, the present study has been explored to achieve the following objectives:

2. Study the effect of reaction parameters on the shape and size of copper oxide and aluminum oxide nanoparticles.
4. Characterization of nanomaterial using scanning electron microscopy (SEM), transmission electron microscopy (TEM), X-ray diffraction (XRD), thermal analysis (TGA/DTA), Fourier transformation infrared spectroscopy (FTIR) and ultraviolet-visible spectroscopy (UV-VIS) techniques etc.
Study the photocatalytic and antimicrobial activities of nanoparticles and nanocomposite for the degradation of organic pollutants.

Study the cytotoxicity of nanocomposites.

In the present work, copper oxide and aluminum oxide nanoparticles has been synthesized electrochemically. The effect of various reaction parameters such as electrolyte, solvent, current and electrolysis time on shape and size of particles were studied. The nanoparticles were reported for better photocatalytic and antibacterial application. Guar gum based copper oxide and aluminum oxide nanocomposites were synthesized using simple sol-gel method. The nanomaterials have been characterized using scanning electron microscopy (SEM), transmission electron microscopy (TEM), X-ray diffraction (XRD), thermal analysis (TGA/DTA), Fourier transformation infrared spectroscopy (FTIR) and ultraviolet-visible spectroscopy (UV-VIS) techniques etc.

Electrochemical method has been used for the synthesis of copper oxide NPs. The effect of reaction parameters such as supporting electrolytes (sodium hydroxide, sodium carbonate and sodium nitrate), solvents (water, water-methanol and water-ACN), current (at 20 mA, 50 mA and 100 Ma) and electrolysis time (30 min, 60 min and 120 min) has been studied. Sodium hydroxide has been selected as best electrolyte for the preparation of copper oxide nanoparticles. Among the three solvent (such as water, water-methanol and water-ACN) water-ACN was selected best solvent for the synthesis of nanoparticles. It has been observed that the particle size decreased with increase in current. With increase in the electrolysis time from 30 to 120 min the size of particle increased. The photocatalytic degradation of methylene blue, congo red and methyl red dye were investigated under sunlight irradiation. The degradation of 93%, 90% and 85% was observed for MB, MR and CR dyes, respectively after 120 min of photoirradiation. The rate of photodegradation of all dyes followed the pseudo-first-order kinetics. The copper oxide nanoparticles were explored for the antimicrobial activity against E. coli, S. aureus, A. nigres and C. albicans strain. The 94% and 91% inhibition of A. nigres and C. albican were recorded and 92% and 88% of inhibition against E. coli and S. aureus were recorded using nanocomposite.
Electrochemical method has been used for the synthesis of aluminum oxide NPs. The effect of reaction parameters such as supporting electrolytes (sodium hydroxide, sodium carbonate and sodium nitrate), solvents (water, water-methanol and water-ACN), current (at 20 mA, 50 mA and 100 Ma) and electrolysis time (30 min, 60 min and 120 min) has been investigated. Sodium hydroxide has been selected as best electrolyte for the aluminum oxide nanoparticles synthesis. Among the three solvent (such as water, water-methanol and water-ACN) water-ACN was selected best solvent for the preparation of nanoparticles. It has been observed that as the current increased the particles size was decreased. The degradation of 40%, 90% and 16% was recorded for MB, CR and MR dyes, respectively within 120 min of photoirradiation. The photocatalytic degradation followed pseudo-first-order kinetics for MB and CR. The degradation of MR dye followed pseudo-second-order kinetics. Nanoparticles were explored for the antimicrobial activity against *E. coli*, *S. aureus*, *A. nigres* and *C. albicans* strain. Aluminum oxide nanoparticles showed negligible inhibition effect against *E. coli*, *S. aureus*, *A. nigres* and *C. albicans* strain.

Guar gum based copper oxide nanocomposite (GG/CuO) has been synthesized. Transmission electron microscopy inferred the formation of spherical of particles size between 20 nm and 50 nm. The degradation of MG dye removal using GG/CuO nanocomposite was studied under two reaction conditions i.e. equilibrium adsorption in dark followed by photocatalysis and synergistic adsorption/photocatalysis directly under sunlight irradiation. The photocatalytic degradation of 87% of dye was removed by adsorption in dark followed by photocatalysis process. 89% of dye was removed in synergistic adsorption/photocatalysis process. GG/CuO nanocomposite followed pseudo-first-order kinetics for the photodegradation of MG dye. The GG/CuO nanocomposite was explored for the antimicrobial activity against *S. aureus* strain. The antibacterial effect was recorded more pronounced at high concentration of GG/CuO nanocomposite. Cytotoxicity of GG/CuO nanocomposite was assessed on three cell lines, viz. CHO-K1, KB and C6. GG/CuO nanocomposite was observed with C6 cell line at concentration of 25 μg/ml (~24%) at 72h.

Guar gum based aluminum oxide nanocomposite (GG/Al₂O₃) was prepared by simple method. TEM inferred the formation of particles size in the range of 20-45 nm. Photocatalytic degradation of malachite green dye was found to be 87% degradation of dye in synergistic adsorption/photocatalysis reaction and 76% of dye degraded
under adsorption in dark followed by photocatalysis reaction. Photocatalytic degradation of dyes was fitted to pseudo-first-order kinetics. The antibacterial activity of prepared GG/Al₂O₃ nanocomposite was screened against *S. aureus*. The antibacterial effect was recorded more pronounced at high concentration of GG/Al₂O₃ nanocomposite. Cytotoxicity of GG/Al₂O₃ nanocomposite was evaluated on three cell lines, viz. CHO-K1, KB and C6. Maximum cytotoxicity achieved by GG/Al₂O₃ nanocomposite at 72 h was ~30% at maximum concentration of the sample (100μg/ml) with KB cell line.