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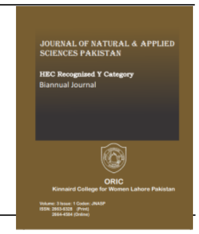

APPLICATIONS OF POLYMER IN ENVIRONMENTAL CHEMISTRY

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Abstract

This review highlights applications of polymer in environmental challenges and emphasizes the pollution control and recovers environmental excellence. Polymers play a very crucial role in environmental challenges like water and waste water management, pollution control, and sustainable practices. Polymer is utilized in water treatment process to remove water contaminants, coagulants, and flocculants and have efficiency to separate pollutants from water sources. Waste management strategies significantly involve in polymer decomposition of organic waste, reducing its environmental impacts and stabilization of waste which prevent it from leaching. Basically, polymers are used to enhance soil stabilization and control erosion. They are used as adsorbents and remove volatile organic compounds like nitrogen oxides and other pollutants from industrial wastes. They are used to utilize the light weight, durable and construction material and minimize environmental impacts on building materials. Polymers contribute to advance the renewable energy and technologies, from light weight and solar cells polymers are used to enhance the sustainability and efficiency to clean energy solutions. Biodegradable and compostable polymers offer traditional and eco-friendly packaging materials which reduce environmental impacts on plastic wastes.

1.Introduction

Polymer are extensively utilizing material in daily life, and have wide range of applications in realm of sciences, industries and technologies (Elias 1997). The word polymer derived from Greek work 'polymerous'. Polus means many and meros mean many (Belgacem and Gandini 2011). Polymers are actually made-up of small repeating units of monomers, and this process in nature has formulated natural polymer and others are man-made synthetic polymer (Gowariker 1986). We acquire polymer from chemical reaction of monomers. Basically, the use of polymer is to comfort and facilitate the human life, like transportation, nutrition, buildings, clothing's containers etc. and according to environmental applications of polymers water treatment, gas sensing, heavy metals ion detection, chemo bio sensor used for the removed of contaminants (Namazi 2017).

2. Polymer analysis

Polymer applications can be analyzed by using different methods such as;

- Continuous analysis
- Conformational analysis
- Vibrational analysis

These methods help to understand the structure properties relation and molecular designs of polymers. Some techniques such as vibrational spectroscopy and infrared spectroscopy are very significant tools for the findings of chemical composition, characterization, molecular structure and orientation of polymeric materials because they help to monitor polymer processing. These useful techniques combined with chemometrics and elaborate the use of infrared spectroscopy for analyzation of polymeric materials, and by this we can easily analyze the polymer applications, analysis and properties (Patterson et al., 2023), (sasanuma *et al.*, 2023), (Bokobza L 2019), (Giulio Malucelli 2020).

2.1 Continuous analysis

Biopolymers are derived from renewable biomass sources and attain devotion due to their potential replacement of petroleum-based polymers, but due lack of understanding their development has become limited. This technique analyzed continuous polymer analysis by using exclusion chromatography which gives a real time insight into processing and properties. Nuclear magnetic resonance spectroscopy has been utilized for polymerization reactions monitoring but their integration should be limited. The adoption of nuclear magnetic resonance spectroscopy into continuous flow like high resonance flow, and NMR coupled with a continuous flow reactor to monitor monomer conversion and distribution of polymerization reactions (Patterson *et al*., 2023)

2.2 Conformational analysis

Conformational analysis involves in different conformations such as polymer chains. Due to flexibility polymers have capacity to assume large number of various conformations, these conformations are characterized by various factors such as enchainment of monomers, co-monomers, stereo sequences and Regio sequences. techniques such as 13C NMR can be used to analyze resonance and local microstructure and macrostructure conformation of polymer chain can be can be exposed by Kerr effect. Some models and methods should be used to identify branch polymer structure these are Erdos-Renyi random graph model and Wei's methods and the macromolecules in solutions can display conformational properties prejudiced by lengthy structure problems which leads to anisotropy of environment (Bing Li 2023), (Viktoria *et al*. 2010), (Ulf *et al.*, 2019), (Haydukivska *et al*., 2014).

2.3 Vibrational analysis

Infrared spectroscopy and Raman spectroscopy can be used to analyze the structure and composition of vibrational analysis of polymer because these techniques can provide information about chain packing, chain conformation and interatomic interactions like crystal and structural transitions. Vibrational analysis used to analyze process of manufacturing monitoring and curing and study stimuli-responsive polymer systems. Raman spectroscopy extensively used to analyze the mechanical structure and relationship of semi-crystalline polyolefins (Di *et al*., 2022), (Bokobza et al., 2019), (Kozanecki *et al*., 2019), (Shaw et al., 2018), (Kida T, 2022).

3.Classification of polymers

3.1 polymer composites

Composites consist of chemically and physically distinct phases which are separated by distinct interface. Composites are basically made up of polymer, metals and ceramics. The polymers and composites gain recognition in modern era with a lot of applications. Polymer composites have two phases matrix (continuous phase) and reinforced (discontinuous) phase. Figure show the classifications of composites on the bases of polymer (Umar *et.al* 2021).

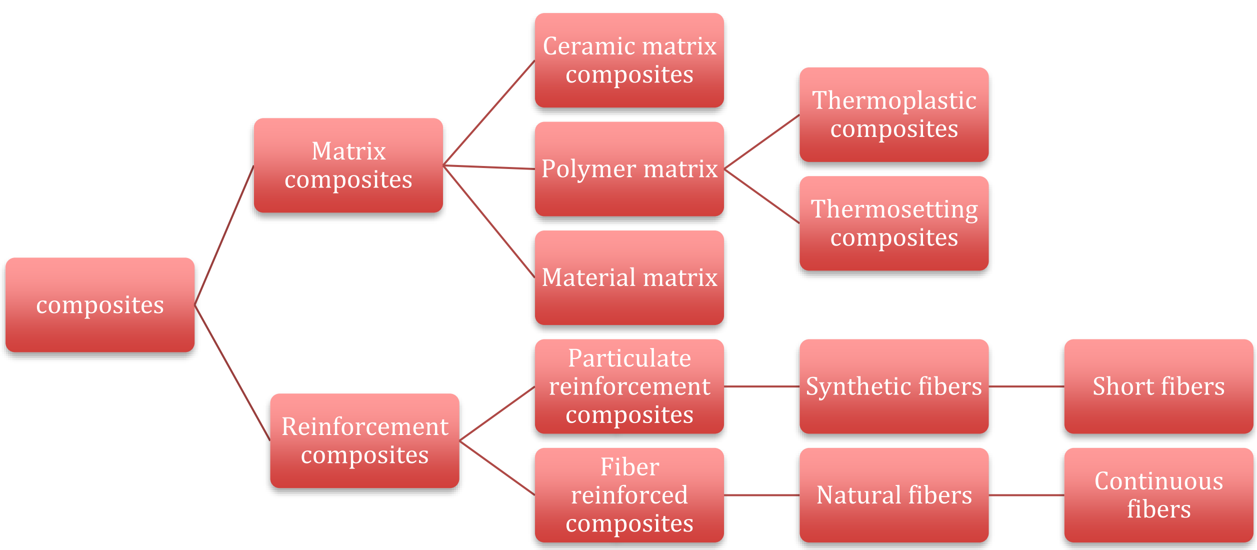

Figure 3.1 classification of composites on the bases of polymer

Environmental pollution is one of the dominant issues in society to survive. Different master planes have been developed to eliminate the pollutants at sustainable energies. We have examined the process of material synthesis and composites formations. A variety of technologies are working to save and produce efficient energy. Different issues are needed to address on industrial and domestic activities which are acceptable to environmental way (Nguyen and Yang 2018).

3.2 *Use of Nano-composite*

The Nano-composites and gas sensing material has proposed in a new approaching material. The structure and Nano composite composition are obtained from X-Rays diffraction and scanning electron microscopy and transmission electron microscopy and tested at room temperature and petroleum gas sensors (pomogailo *et al*. 2014) Organic conducting polymers and carbon nanotubes polymers help to determine the traces of heavy metal ions in water, because they are stable in environment as well as they possess good electrical mechanical and chemical properties. Most of them have some limitations in the direction of sensitive metal ions detections. To control these limitations organic conducting polymers and nanotubes polymer have been utilized (Deshmukh *et al*. 2018). Chitosan cellulose and Nano crystalline cellulose are extensively used in polymer applications and conducting polymer are rapidly use for the development of sensing layer in environment. These all are used for the reduction of water pollution that is very serious issue in recent decade. The impressive and convincing polymer have different properties and widely applied in sensing applications. The conducting and biopolymers have novel conducting composites with good selectivity and sensitivity for different types of heavy metal ion detection. The environmental sensors can generate the integration of polymers with metal ions, and the demand for surface Plasmon will increase in future for wide range of applications (Ramdzan *et al*. 2020).

3.3 Polymer water treatments

Polymers play very important role in waste water treatment like separation solids from liquids etc. by the removal of water contents from waste water change the waste properties. Different chemical and physical properties are used to modify for natural ion polymer performance. One of the magnificent issues is to sustain the current society assure the desire quality of water resources. To label this challenge membrane water treatment is look ahead to play important role in society like drinking water treatment and wastewater treatment and reuse it. Water is the substructure of life. Water pollution, water shortage, misuse of water become a serious problem (Ng *et a*l. 2013) membrane water treatment is expected to play a vital role in drinking water treatment and also waste water, because it is not involved in the phase change chemical additives (Robeson 1991). Work on polymer matrix membrane for water treatment has enormous in recent years. Nano material supply membrane with unique properties and generate new characteristics, functions and their effects (Yen and Deng 2015).

3.4 Polymer waste-water treatment

Figure 2,3 4 and 5 tells about CH_4 and N_2O are produced during the industrial wastewater collection treatment. The slugs generate microbial CH_4 and N_2O which are emitted without gas. Due to the sustainable infrastructure for water treatment is typically small and incidental and bio gas are used for heating process. The highest percentage for CH_4 emission from wastewater is Asia (China, India) and total global CH_4 emission is about 45% from 1990 to 2020. N_2O is very low in emission during this period. The regional emission of N_2O is basically largest amount in Asia, Africa, South America etc. 70% estimation are counted in 1990 compared with 1990is expected that the 2020 emission will rise about 20% (Solomon 2017).

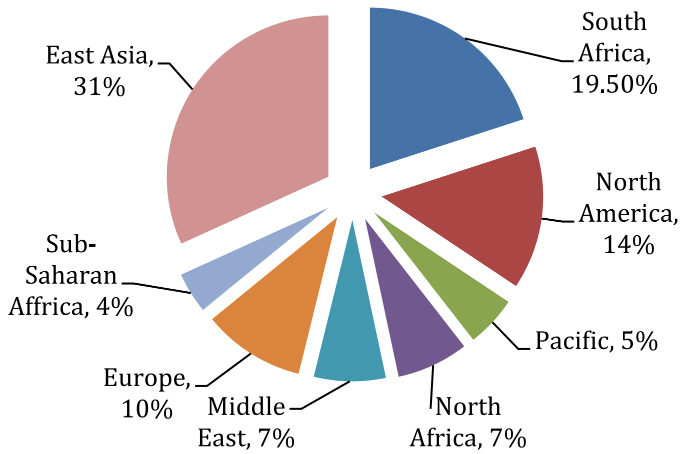

Figure 3.2: Waste water CH_4 less ions 1990

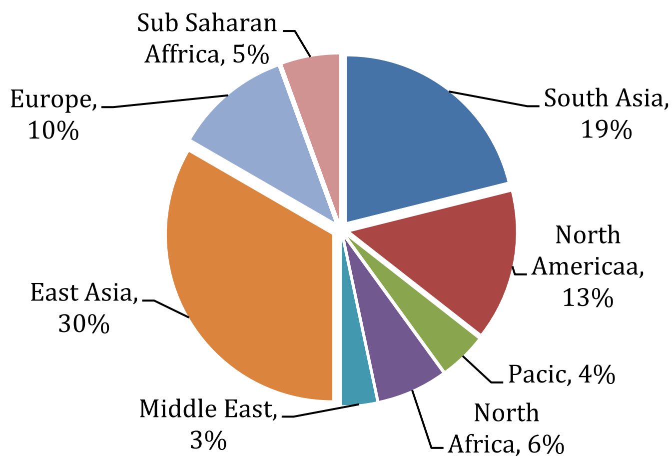

Figure 3.3: Waste water CH_4 emission 2020

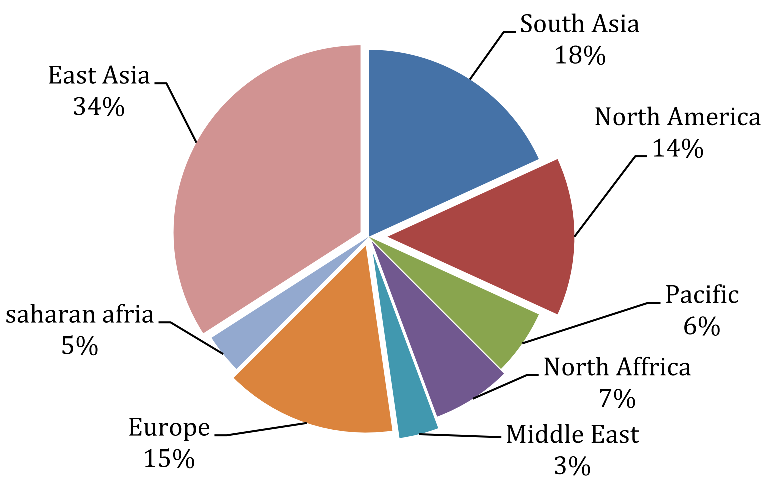

Figure 3.4 N_2O emission 1990

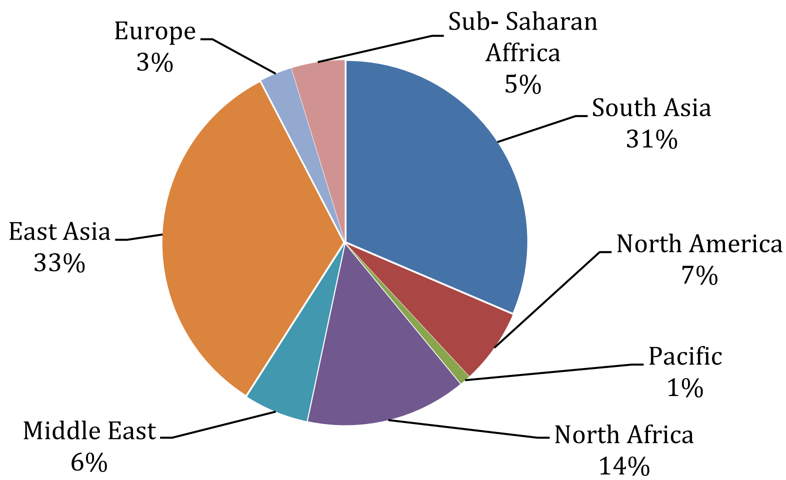

Figure 3.5: N_2O emission 2020

The figures of CH_4 and N_2O demonstrate the regional distributions of waste water emission from 1990 to 2020Various techniques are available to remove impurities from industrial waste water and micro pollutants chemical precipitation (Brbootl et.al 2011) Conventional coagulation (Hyung and Kim 2009) Removal of metals and ions (Vaaramaa and Letho 2003) the choice of treatment of wastewater and characteristics are based on concentration of pollutants (Gupta and Bhattacharyya,2006). Different types of adsorbents are used in water treatments which are main examples of high-performance adsorbents like alovera Bio mass are used to remove organic and inorganically pollutants from water (Giamakoudakis *et al* 2018). Resins are used for water and waste water treatments over the last decades. It is used for high potential resources and underutilized in different fields (Elwakeel 2010) silica network are very advanced adsorbents for environment. They are available in very low cost, large surface area and high porosity (Morin-Crini*et al* 2019). Zeolites are synthetic in nature and are extremely used in waste water treatments like purification and water softening. These zeolites are generally made up of alkali silica; alumina and production from waste water enhance their popularity (Shoumkova 2011). Activated carbon is used as waste water treatment for industrial effluents and many charged substances are measured according to their models (Ban *et al*. 1998). Recent global issues have some challenges to use natural resources, inorganic and inorganic impurities endanger human health. Production of industrial waste water has possibilities to recycle residues and create new materials for energy and material (Wollmann *et al* 2019).

3.5 Water quality challenges

Nanotechnology offers exciting possibilities in addressing water quality challenges through the development of advanced materials and processes such as Nano sorbents, Nano catalysts, bioactive nanoparticles, nanostructure catalytic membrane, Nano-particle enhance filtration, revolutionary water desalination and reducing harmful concentration. The applications of Nano-materials in water filtration holds a great promise for addressing water quality issues various sources (Savage and Diallo 2005) Polymer Nano-composites (PNCs) represent a cutting-edge area of research at the intersection of polymer science and nanotechnology. These materials involve the dispersion of Nano-fillers within a polymer matrix, offering a range of advantages over traditional composites that use micro-scale fillers. The rapid progress in polymer science and nanotechnology has propelled PNCs to the forefront of material innovation. PNCs exhibit significantly enhanced overall performance compared to conventional composites. The incorporation of Nano-fillers at the Nano-scale imparts unique properties, such as increased strength, stiffness, and thermal conductivity. PNCs show promise in applications related to environmental remediation. Their enhanced properties can be harnessed for the removal or degradation of pollutants, contributing to sustainable and efficient solutions for environmental challenges. Polymer Nano-composites hold great promise across various applications, showcasing recent advancements in environmental remediation, EMI shielding, and sensing & actuation. Addressing challenges such as uniform dispersion and scalability will be crucial for unlocking the full potential of PNCs in diverse industrial sectors (Wei *et al.* 2020).

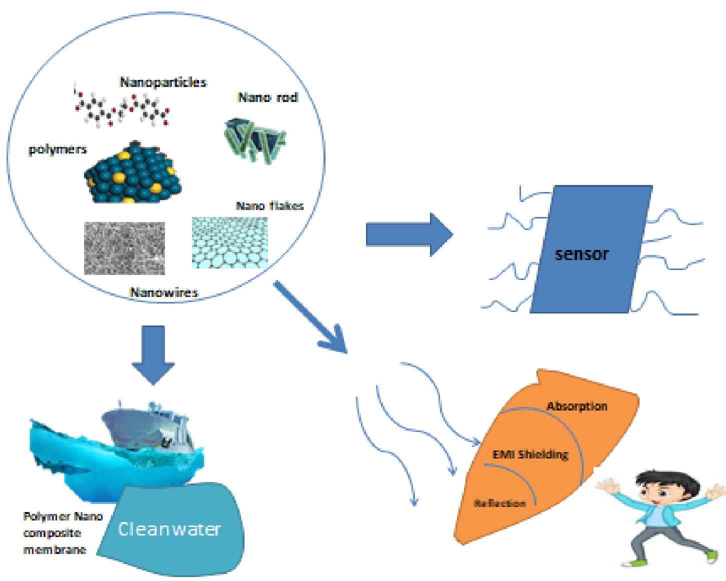

Figure 3.6: multi-functions of polymer

Stimuli-responsive polymer materials are a leading-edge subject in ingredients science, providing a flexible stage for tackling a wide range of complications in a diversity of applications. Fig explain the materials have special abilities that allow them to adapt to their environment and respond to external stimuli, making them extremely useful in a variety of sectors. Here's a summary of the main themes debated in the passage. Receptive polymer materials may respond to changes in their environment. This adaptability is predominantly beneficial in applications where active responses are essential. These materials can regulate the flow of ions and molecules, which is important in applications such as medicine management when controlled publication is required. Reactive polymer materials may respond to changes in their environment. This adaptability is particularly beneficial in applications where dynamic reactions are required. The receptive polymer materials characterize a gifted boundary with huge applications, and continuing research aims to overwhelmed contests and desire the limitations of what is feasible in this stimulating field of materials science (Stuart et al.2010).

3.6 Nutrients use as protective environment

The access of nutrients in gel and protective environments and some unique combination of some solid structures like gelatin make coordination polymer gels a versatile and dynamic class of materials in different applications such as the formation of coordination polymers involve in metal ions. The notable feature of coordination polymer is their reversible nature which recycles the gel formation and solvation. The solid and liquid composition of coordination polymers is quite interesting because they enable the movement of animals through gel system. The combination of structural and reversible stability makes coordination polymers a promising application in nanotechnology, environmental science and many other fields (Jung *et al.* 2013). Substances like extracellular polymer substances have a complex mixture of biopolymer and it play very important role in microbial aggregation and biofilms formations. The multifaceted nature of EPS has various polymers and inorganic components which contribute in water and wastewater treatments. Carbohydrates are one of the major extracellular polymer substances provides adhesive and promote aggregation of microbial cells. The environmental applications of extracellular polymer substances are diverse and promising in water treatment act as natural flocculants which remove pollutants from water (More et al. 2014). In figure Some nanoparticles are used for water purification like Graphene, carbon nanotube, quantum dots, Dendrimers, fullerene, chitosan, polymeric nanoparticles and nanowires are used for the purification of water.

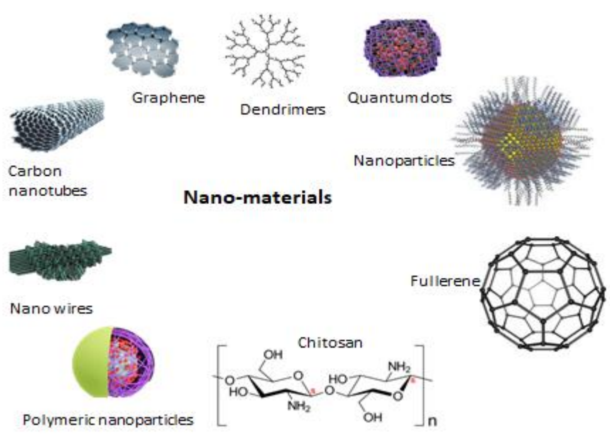

Figure3.7: Use of nanoparticles in water purification

3.7 Conducting polymer

The conducting polymer combined with different species to make strong potential and electrical sensor. The polymer-based reaction has potential to provide electrical signals transduction processes. These polymers have a large number of morphological and physicochemical properties and help to increase the sensing ability and provide a large surface area to interact with other chemicals like, new signal transduction mechanism. To attain hybridization of different types of polymer materials we will center the qualities of polymer sensing applications and their limitations on state-of-law trends to face different challenges includes importance of different counting polymers (Park S *et al.* 2017).

3.8 Polymer as gas sensors

Recent study on gas sensor based organic sensor elements review on pathlycayanin show a good response and combine with maximum sensitivity to produce N2O. A short-firing is generally produced and checked by phthalocyanine in coal mines and are operated at 170ºC (Miasik 1986). Conducting polymer has a wide range of applications in chemical gas sensors due to their innovative nanostructure good synthesis and stable in environment at room temperature. Due to their distinguished structure and morphology. the diversification has been progressed to alternate the nanostructure of conducting polymers. To concentrate on field effect polymers gas sensors to unsettled simple mechanism, comfort fabrication, low cost and high degree of freedom to overcome device size. The sensors change their conductivity resistance to interact with polymer (Liu *et al*. 2022).

Table 3.1: Inorganic conducting polymer in gas sensors

CP	Hybrid material	Analyte	Response time	temperature	Detection limit	references
	Zno	TEA	66-132s	RT	11ppm	Quan et al. 2017
	SnO_2	NO_2	6 min	RT	50ppb	Betty et al. 2015
	WO_3	Acetone	-	RT	11ppm	Hicks and killard 2014
PANI	ZnO NPs	NH_3	51 s	RT	25-99 ppm	Talwar et al. 2014
	Cu NPs	NH_3	73 s	RT	1-50 ppm	Patil et al. 2015
	Pd NPs	NH_3	90 s	RT	6 ppm	Cho et al. 1955-1966
	Au NPs	H_2S	-	RT	1.5 ppm	Liu et al. 2012

Polymer nanowires are used for gas sensing, when gas sensors show resistance of 10.5% to 9% the acetone show saturation and vapor pressure and the response of sensor reproducibility in time have excellent recovery (Dan *et al.* 2007). In sensing array technology is used like agricultural storage, emission control and clinical assaying have significant importance in market due to their outstanding efforts. For example, a patient suffering from diabetes and have acetone concentration rate of breath is 6ppm, and it will increase to 300 ppm (Fleischer et al. 2002).

3.9 Nanomaterial based chemical sensors

The nanomaterial based chemical sensors provide a great opportunity to grip knowledge on physical and chemical scaling methods and also on microscopic sensors. It suggests that one dimensional nanowire elements have large surface area and ratio over thin film which increase its sensitivity and confinement (De Melo*et al*. 2005). Micromachining technology is used to develop polymer based chemical gas sensors, sensors are polymer carbon composites films are swell reversibly cause resistance and change a wide verity of gases. Two types of devices can measure the resistance of well designs, these wells contain polymer carbons during deposition and allow the sensor to reproduce well constrained area (Zee and Judy 2001). The capacity to judge and detect different chemical gasses is very important for various applications like environmental monitoring, detection and availability of toxic gases from leaks (Gardner et al 1994).

3.10 Global warming

Greenhouse gases put up global warming and have great efforts to use gas sensors and to find out some levels of carbon dioxide which produce various problems in developing chemical sensors. Conventional methods of finding carbon dioxide involve infrared spectroscopy and also gas chromatography, and some equipment's are available which are very expensive and bulk in size. So that the miniaturization and simplification of carbon dioxide are try to reach over worldwide (Chiang *et al*.2013).

3.11 Detection of Heavy metal ions

Carbon nanotubes, multi-walled carbon nanotubes and single walled carbon nanotubes and Nano fibers are applications of Nano scale carbon-based materials, used in electronics, environmental and health care sectors. The figure explain applications are used in heavy metals ions and sorption for spectroscopic and chromatographic techniques and an electrode is used for the detection and sensing material to know about their properties.

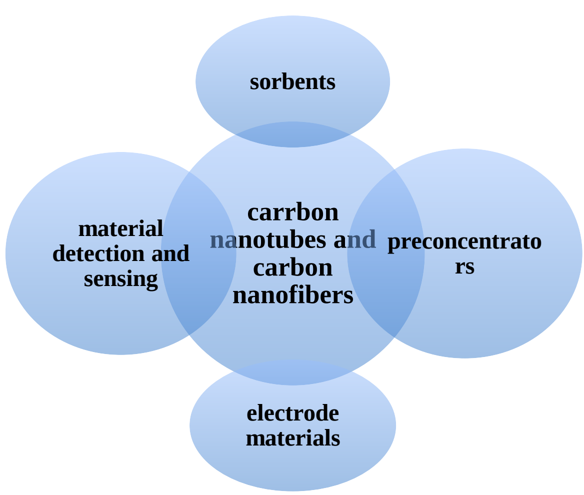

Figure3.7 Heavy metal ion detections

The fabrication and modification of electrodes are widely used in electrochemical processes like stripping analysis, transistor-based devices and heavy metal sensing and detection will be highlighted (wanekaya 2011). Heavy metal ions are present in huge amount in our aqueous system and cannot be degraded easily which are very dangerous for human being. Ions are assembled in organism and become more toxic which directly intrude into metabolism, toxicity and different disordered will harm oxidative stress. To remove different types of ions from water various techniques are used like, spectroscopic detection, atomic absorption spectroscopy, graphite furnace absorption spectroscopy, atomic fluorescence spectroscopy and X-rays fluorescence spectroscopy (Malik *et al.* 2019). Different frequencies are emerged together for the investigation of polymer structure and its molecular surface. The findings tell us about surface and structure of common polymers like surface restructuring in water, polymer gradual changes in blend surface small end groups etc. The study on surface polymer such as glass transition, and modification induced by plasma deposition, oxygen ion and radical exposure and wet etching. Different researchers find the valuable insights correlations between polymer and its surface properties and conclude that polymer contain specific and desired surface characteristics (Chen *et al.* 2002).The potential applications of Nano scale inorganic polymer and the environmental remediation special the removal of various contents present in water are selective removal contaminants such as ZnO, FeO, magnetite crystals have capabilities for specific contaminants like heavy metals, metalloids and organic compounds. They have very high surface area to volume to ratio and have some limitations on their advantageous properties. Polymer supported nanoparticles are highlighted for their reusability and reprocessing over multiple cycles of operations (Cumbal *et al.*2003). Early human settlements have emerged near new water sources such as rivers lakes and substance and agriculture. The research focuses on the development of sustainable water treatments technologies to address emerging contaminants. Nobel metal crystals are explored for the removal of pollutants from water. The insights understandings of water and quality of water provide intricate relationship between elements and human civilization development (Pradeep,T 2009). The utilization of copper nanoparticles in paper filters point of the use water purification is promising and environmentally friendly. A nanoparticle is alternative to silver nanoparticles and supposed to be cost effective and have potential of antibacterial properties of copper. The direct preparation of copper nanoparticles in paper uses ascorbic acid as reducing agent. Characterizing the paper sheet in various techniques such as X-rays diffraction, scanning electron microscopy, energy dispersive X-rays spectroscopy and atomic absorption microscopy provide a comprehensive understanding of structure and composition of material. This study provides a promising and environmental methods for water purification, addressing both anti-bacterial efficiency and cost-effectiveness (Dankovich & Smith 2014). The implementation of nanotechnology in drinking water treatment is indeed a promising avenue for applied research, aiming to enhance the efficiency and sustainability of removing heavy metals from water sources. The focus on reducing the dimensionality of conventional adsorbents is a key aspect, and engineered nanoparticles present potential improvements if certain challenges can be addressed such as technical and economic conditions, removal of heavy metals ions from drinking water etc. the study tells us about the potential of nanotechnology and improve drinking water treatment efficiency with focusing on removal of heavy metal ions. Addressing technical, economic, health, and environmental considerations is crucial for the successful and responsible implementation of nanomaterial in water treatment plants (Simeonidis *et al.* 2019).

3.12 Soil stabilization

Polymer are used as soil stabilizer help to prevent erosion and improve soil quality. The use of polymers for soil maintenance in concrete and geotechnical engineering has been studied. First, the structures that stimulus the efficiency of common polymer classes, such as geopolymer, biopolymers, and synthetic organic polymers, are studied. These comprise the kinds and ratios of geopolymer precursor and activator, as well as the molecular weight, particle size, charge, conformation, solubility, viscosity, pH, and moisture performance of organic polymers. The study then discusses the processes that regulate soil stability with different polymer classes. The primary developments for organic polymer-clay connections are electrostatic forces and entropy rise, which change at the compassion of on whether the polymer is cationic, neutral, or anionic (Huang *et al.* 2021). Polymers are very large molecules made up of different repeating units called monomers. Basically they are formed by the polymerization of monomers and have physical and chemical properties which differ from monomers. Natural and synthetic polymer both help to stabilize soil contents (Georgees *et al*. 2017), (Sojka *et al*. 2007), (Sukmak *et al*. 2013). S-type and E-type stabilizers are used for the stabilization of soil, different concentration stabilizers were tested first in soil aggregates and possess different size range bigger than 5mm and smaller than 10mm. static water measure methods are used for testing aggregates which helps to increase soil stabilization as well as concentration. S-type stabilizer has 20% to 40% concentration range which result k value 64% and 83% and E-type polymers concentration is 3% to 7% only which result in k values between 90% to 99%. S-type stabilizers are preset in high concentration and E-type stabilizers are present in low concentration and both can follow exclusive collapse pattern (Liu et al. 2009). Polyacrylamides are very effective polymer for the stabilization of soil-aggregates. They help to decrease erodibility of soil and have favorable effects on water infiltration in soil. Polymer are mixed with soil then subjected to wetting, drying, and are applied to cultivated soils. Many polymers are available which help to decrease soil erosion such as improvement of water penetration, as less water penetration and cause less erosion, water stable aggregates reduce soil erosion, wetting soil surface, drying soil surface and spraying polymers in solution, applying polymers to soil to decrease soil erosion, applying polymer to overcome erosion dust by wind (Wallace and

Wallace 1986).polymeric material have a wide range of applications for water saving and crop yielding in agricultural field (Tian *et al.,* 2019). In soil the organic carbon and aggregates are main pointers of soil quality, help to find out the properties of soil. The quantity distribution and preparations of different size control soil pores spreading help to find out hydraulic properties and permeability and soil activity as well as preservation of supply (Zhang *et al.*, 2012). The number of residues is produced by agricultural, industrial and urban processes have been increasing the use of different types of management methods. The disposal in may situations may be incorrect which leads to environmental pollution from metals as well as increase in disease transmission through insects. Collective methods are used for controlling the residual waste including landfilling, incineration, composting and energy generation. Composites are made up of ceramics polymers and metals which help to reduce leaching of substances and increase mechanical, thermal and acoustic qualities. Waste fillers are used to enhance the provided barriers (Cabrera 2021).

3.13 Packaging and waste management

Polymer goods like plastics are generally produces and extensive utilizing due to their essentials benefits in material making which is a paradoxically a threat life on earth. The process of polymer recycling is mostly recognizing solution to rise danger of plastic waste such as separation, sorting and cleaning issue (Okan *et al.*,2019).

Figure3.8: Challenges and strategies for effective plastic waste management

Our better hyper-hygienic style of living the transmission of behavior pattern is fear able like usage of personal protective equipment's increase plastic desire for plastic food packing and goods. The deficiency of our management system will increase environmental disasters. To limit the danger, use of sterilization and sealed bags for safe disposal should be implemented. To reduce plastic pollution in environment plastic management technologies should be applied (Vanapalli *et al*., 2021). Environmental pollution is the major issue in world. Pollutions is caused by chemicals which are toxic in nature such as air, water and soil pollution which destruct the biodiversity and degrade human life. Pollution is increasing day by day and required superior development. Nanotechnology has three main abilities that can be functional in environmental field, counting remediation, purification and detection of contaminants (Yunus *et al*.,2012). Polymer electrolyte membrane fuel cell system is one of the most important and promising system for electric cars due to its ability to start quickly. In order to understand the design concept and development status of fuel cell system for electric vehicles improve performance durability of fuel cell and most targeting such as density, operation, dynamic response and lifetime in system (Wang *et al*.,2018). Textile manufacturing is one of the highest polluting industrial sectors. It uses a large number of chemicals in carcinogenic because textile industry emits dangerous chemicals like heavy metals, water streaming soil as well as toxic gases. These dangerous cause man diseases and various problems to human health such as heart disease. Pollution from textile production across the world enormous harm to environment including textile, polymer and dyes. Some fundamental materials and process identified raw material and their transformation into fibers, yarns, dyeing, printing, finishing to textile and further processing will be investigated (Aldalbahi *et al*.,2021). Air pollution caused by textiles which influence human's machinery system and goods, water pollution is extremely vulnerable to other types of pollution system associated to textile industry by public (Fletcher 1998). Fiber and chemicals are harmful in air if they are degradable under water and sunlight produces poisonous agents such as nylon, polyester and other polymeric materials (Park *et al*., 2016). Noise pollution is rises by wavy process high noise may occur transportation system which hints to loading, shipping and handling in textile industry (Capezza *et al*.,2019). Both renewable and non-renewable resources are desired threat in textile industry (Muhammad F 2014).

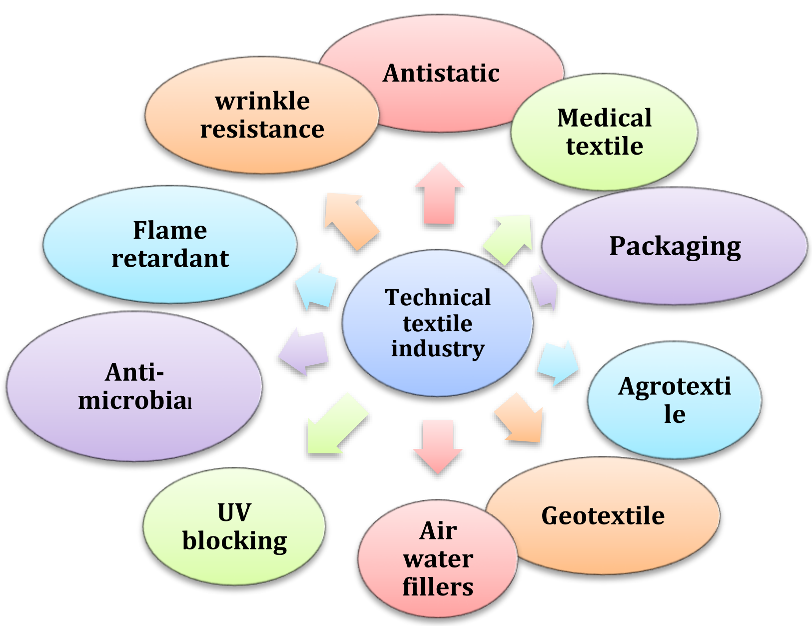

Figure3.9: Various applications of medical textiles environmental and agricultural which impacts on air, water and soil

The development of packing material usually occurred in bio-polymers that can be renew every year and have gained a lot of consideration due to its extreme demand in high quality food products which fears to environmental waste difficulties such as draw backs of natural polymer and low mechanical barrier quality can be addressed. Natural biopolymer is easily processed by microbes which makes it highly biodegradable. This is most hopeful application in industry and packaging materials (Attaran *et al*., 2017). Polyolefins and natural polymer blends are used in packaging materials and non-renewable polymers are careful as a somber issue in environmental complications and it became a massive contest to waste management. Polysaccharide starch, chitin, chitosan, protein lignin and natural rubber are chief degradable blends with chosen properties (Sam et al., 2014).

3.14 Conventional synthetic polymers

Conventional synthetic polymers are extremely utilizing polymers in packaging materials due to its very low cost, density and easy processing because they do not degrade and pollute environment. Polymer are perfect substituents for synthetic polymer in polymer packaging applications due to their decomposable and humble nature such as cellulose, starch, polylactic acid are cast-off in food due to its non-edible packing applications etc. (Singh *et al.*,2021). The main purpose for food packing is to preserve food from contamination by the use plastic materials such as metals, ceramics and papers. Plastic and polymers are basically used in packaging material in industry e.g. petroleum polymers are used in production of materials at first and last due to its thermal, mechanical and resistant of solvent properties. Bioplastics are used at commercial products made up of natural sources, and chemically used to find out fossil fuels counterparts because they are renewable, compostable and biodegradable. Polypropylene, polyvinyl chloride and polystyrene these are petroleum plastic polymeric materials. Due to manufacture of plastic material CO_2 is shaped which is very real for our environment but due to their widespread use they are in achievement in food packing industry in few past years (Tajeddin and Arabkhedri 2020).

4. Limitations

The addressing limitations are involved in research development t efforts to improve the properties, sustainability, enhance recycling and explore alternative materials and their methods are processed and some reasons are listed below;

- Polymer are expensive due to their complex synthesis, materials and making them less competitive to other certain applications as alternative materials.
- Polymer are limited in their recyclability, so efforts are being made for the improvement of recyclability but still face challenges in collection, sorting and p5ocessing which leads to the limitations in their lifecycle managements.
- Some polymers are disposed to to engross moisture from environment hich affect their stability, mechanical properties and their performance for long term against humid conditions.
- Some polymers are not biodegradable and can persevere in environment for long time.

- Some polymer is engineer to have desirable properties like, mechanical strength, toughness, flexibility but should not always match to traditional materials such as matals and ceramics which can limit their structural applications.
- Polymer are excellent in chemical resistance for certain chemicals, other may degrade to specific solvents but acid and bases can limit their sustainability in certain applications.
- Polymers have temperature limitation s because many polymers are temperature sensitive because they melt at extreme temperature which can resist the use of high or low temperature environment.

5.Future perspectives

For future the polymer is used as sustainable material for environmental concerns and have great attention on renewable sources such as biomass, so that these materials will give recommendation for carbon footprints reduction and offer recyclability and sustainability. polymer research endures to explore advance functionalities such as self-healing shape memory etc. amalgamation and nanotechnology will upsurge the properties which help to revolutionize the production progression and biomedical applications will paybacks polymer as drug delivery because polymer-based solutions are contribute in functional coatings and energy technology pouring improvement toward effectual and justifiable future. The diverse properties and dispensation capabilities for current polymer have frequent prospects for revolution and advancement for an extensive variety of industrial applications.

6.Conclusion

Polymers play important which includes pollution control, waste management and remediation. In water treatment they are used as flocculants and absorbents to remove water contaminants. Polymer helps in waste management techniques to reduce plastic pollution and also limits the leaking into groundwater. To summarizing toxic chemicals in soil stability and sedimentation control environmental rehabilitation. As we know technology increase investigation process and have novel approaches in environmental concerns and have a wide range of uses are critical in many sectors, because they are versatile light weight, automotive, easily recyclable and extremely corrosion resistant useful in many chemical and environmental circumstances.

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