

# METAL ORGANIC FRAMEWORKS (MOFS) AND COVALENT ORGANIC FRAMEWORKS (COFS): A BENEVOLENT AND VERSATILE SCAFFOLD FOR MULTIFUNCTIONAL UTILITIES IN SCIENCE AND TECHNOLOGY

## Abstract

Metal-organic frameworks (MOFs), made up of organic ligands and metal ions which are highly porous, crystalline materials while Covalent-organic framework(COFs) are a class of penetrable crystalline material that are connected by strong covalent bonds. Their penetrability, chemical constitution, size and shape, and simple surface modification make this large family most famous for numerous applications like in oral drug delivery, catalysis, adsorption and sensing of various pollutants especially water, used in electrochemical applications, in photocatalysis or used as biomarkers. Various methods are practiced for the synthesis of MOFs and COFs like microwave assisted synthesis, mechano chemical, sonochemical methods, etc.

**Keywords:** Metal organic framework (MOF), Covalent organic framework(COFs),applications, synthetic tactics,scaffolds, organic/inorganic -matrix, benevolent functionality.

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## I. INTRODUCTION

Metal-organic frameworks (MOFs) and covalent organic frameworks (COFs) represents a relatively new family of penetrable materials that have attained remarkable engrossment in the scientific society due to their captivating properties and probable utilities.. The history of MOFs can be traced back to the early 20th century, but their development as a distinct field of research began in the 1990s.

**1. Metal Organic Framework (Mofs):** Metal–organic frameworks (MOFs) , as a type of translucent penetrable composite matter, are made up by inorganic building units or metal ions coordinating with electron-donating organic ligands . They are also called as coordination polymers made up of inorganic–organic composite structure . Their structures contain central metal ions as connectors and organic ligands as linkers.

Although, most MOFs tested to date are obtained from unrenewable petroleum derived chemicals raw-material and transition metals. One of the roadblocks when synthesizing MOFs from real unprocessed products results from the repeated disorganization of the building units, which do not typically result in significantly high penetrability or firmness. The high translucent property and penetrability of MOFs along with manageable and reconcile penetrable structures have led to extensive research of MOFs.

**2. Early Development:** The concept of coordination polymers, which are the basis for MOFs, can be detected back to the late 19th and early 20th centuries when researchers initiated studying coordination compounds formed between metal ions and organic ligands. These early studies laid the groundwork for understanding metal-ligand interactions.

**3. Birth of MOFs:** The term "metal-organic framework" was first introduced in a 1999 paper by Omar M. Yaghi and colleagues. The researchers synthesized a porous material, known as MOF-5, using zinc oxide clusters and 1,4-benzenedicarboxylic acid as organic linkers. This groundbreaking work marked the birth of MOFs as a distinct category of porous materials with tunable properties.

**4. Rapid Expansion and Diversity:** Following the discovery of MOF-5, the field of MOFs expanded rapidly. Researchers began to explore various metal ions and organic ligands to create a wide range of MOF structures with various aperture dimensions, configuration, and performance. The diversity of MOFs allowed for utilities in numerous areas, including gas storage, catalysis, drug delivery, and sensing.

**5. Challenges and Advances:** Despite the promise of MOFs, their practical applications faced challenges related to stability, scalability, and cost. Some MOFs showed instability in the presence of moisture or harsh conditions, limiting their real-world applications. Researchers focused on improving the stability and developing post-synthesis modifications to tailor the properties of MOFs for specific applications.

- 6. Beyond MOFs:** As research continued, scientists explored new classes of penetrable substances related to MOFs, like covalent organic frameworks (COFs) and penetrable coordination polymers (PCPs). These materials offered additional possibilities for diverse applications.

MOFs are portrayed by broad aperture superficial area, with micro- and meso apertures, and broad pattern of aperture dimensions, configuration, and performance and hence benefited in numerous fields like catalysis, adsorption and sensing of effluents especially water or in oral drug delivery, gas storage and separation, etc. Aside from all these utilities in latest years, there is an escalation attentiveness in disclosing the numerous utilities in the electrochemical branch like advances in supercapacitors, batteries and fuel cells, hydrogen evolution reaction (HER), oxygen evolution reaction (OER), and oxygen reduction reaction (ORR), electrochemical degradation of highly oxidizing and harmless compounds, electrochemical sensors, etc.

Metal-organic frameworks (MOFs) are a branch of penetrable substances made up of metal ions (nodes) attached to organic ligands (linkers). These substances exhibit a wide range of properties, making them highly versatile and applicable in various fields. Few of the key properties of MOFs comprise:

- 7. High Superficial Area:** MOFs typically have exceptionally high superficial areas, often exceeding thousands of square meters per gram. This high superficial area arises from their porous nature, providing ample space for gas adsorption, catalytic reactions, and other interactions with guest molecules.
- 8. Tunable Porosity:** MOFs offer tunable porosity, meaning their pore sizes and shapes can be customized during the synthesis process. This property allows researchers to design MOFs with specific adsorption properties for various guest molecules, making them valuable for gas storage and separation applications.
- 9. Large Voids and Channels:** MOFs often have large voids and channels within their structures, allowing for the accommodation of bulky guest molecules. This property is crucial for utilities in storage of gas, catalysis, and drug delivery, where molecules of varying sizes need to be accommodated.
- 10. Gas Adsorption:** Because of their high superficial area and adjustable penetrability, MOFs can adsorb and store significant amounts of gases, such as hydrogen, methane, carbon dioxide, and other small molecules. This property is relevant for gas storage, purification, and separation processes.
- 11. Selective Adsorption:** MOFs can exhibit selective adsorption behavior, where they preferentially adsorb specific gas molecules over others. This property makes them valuable for gas separation and purification applications.
- 12. Catalytic Activity:** Some MOFs possess inherent catalytic activity due to the presence of metal sites within their structures. These metal sites can facilitate chemical reactions and provide unique catalytic properties, making MOFs attractive for catalysis applications.

- 13. Framework Flexibility:** Certain MOFs exhibit framework flexibility, meaning their structures can undergo reversible structural changes upon exposure to exterior impulses, like temperature, pressure, or guest molecules. This property is relevant for applications in gas storage, molecular sieving, and stimuli-responsive behavior.
- 14. Thermal Stability:** Many MOFs exhibit excellent heating stability, permitting them to withstand high temperatures without important deterioration. This property is essential for utilities in catalysis and gas storage, where stability under operating conditions is crucial.
- 15. Photoluminescence:** Some MOFs display luminescent properties, emitting light when excited by ultraviolet or visible light. These luminescent MOFs have potential applications in optoelectronic devices, sensors, and imaging agents.
- 16. Water Stability:** While some MOFs are sensitive to moisture and may degrade upon exposure to water, efforts are being made to develop water-stable MOFs, making them suitable for applications in humid environments and aqueous processes.
- 17. Versatility and Functionalization:** MOFs can be easily functionalized by introducing different organic ligands or modifying their structures, leading to a wide range of tailored properties and applications.

## II. SYNTHETIC APPROACH OF MOF'S

There are various synthetic routes for the fabrication of MOFs. The most usual and simple method is the solvothermal method. In this method a mixture of metal salt is permitted to be heated, and organic connectors are dissolved in a solvent, above the boiling point of the solvent itself. Different approaches involve sonochemical, microwave-assisted, electrochemical, mechanochemical synthesis; these methods vary in how energy is introduced in the artificial system and depends upon various factors like reaction time, yields, size of particle, structure and dimension.

The fabrication of metal-organic frameworks (MOFs) has captivated many researchers during the previous 2 decades because of the chances to get a huge types of fascinating structures and dimensions and that could also be of appreciable significance for utilities in numerous areas related to penetrable materials which are depends on the aperture dimension and configuration as well as the interactions between the host and guest involved.

Concerning the fabrication of MOFs, often the word “design” has been utilized. There have been debatable conversation about this word and an fascinating conviction has been given a little while back. The more firm explanation of “design”, which indicates “to create, fashion, execute, or construct according to plan” (Webster’s Dictionary), generally is not relevant in MOF fabrication. Nonetheless, the explanation and its inference have aid to enhance the area of MOF.

The conventional fabrication are the reactions which is carried out by conventional electric heating. The main factor in the fabrication of MOFs are the temperature of reaction,

and two different temperature scales, solvothermal and nonsolvothermal, are normally differentiated, which edict the type of reaction conditions that have to be utilised.

### III. ALTERNATIVE SYNTHESIS ROUTES

By numerous methods energy can be offered for example by an electric potential called as electrochemistry, mechanical waves called as ultrasound, electromagnetic radiation, microwave irradiation called as microwave-assisted synthesis, utility of an electric potential called as electrochemistry and mechanically called as mechanochemistry.

- 1. Microwave-Assisted Synthesis:** Energy can be introduced through microwave irradiation which is a well established approach in man-made chemistry but has been largely used in organic chemistry. Microwave-assisted fabrication depends on the combination of electromagnetic waves with moving electric charges. They may be a polar solvent molecules in a solution or electrons/ions in a solid. Because of the direct combination of the microwave radiation with the solution or reactants, MW-assisted fabrication shows a very high energy amplified approach of warming. Thus, homogeneous and high warming percentage throughout the sample is attainable by microwave assisted synthesis. Microwave ovens helps to maintain temperature and pressure conditions at the time of reaction suited for the synthesis of required material and thus permit a more accurate command on reaction circumstances. Reaction conditions required for MW-assisted fabrication of MOFs includes temperature above 100°C with reaction times rarely exceeding 1 hr. Some reports also described some parameters in order to control reaction like reactant concentration, reaction temperature, power level, molar ratio of the reactants, solvent, irradiation time etc. In common, MW irradiation permits rapid fabrication of small sized crystals compared to CE heating.
- 2. Mechanochemical Synthesis:** In this type of synthesis mechanical force is used. Mechanical force are responsible to accelerate many physical processes and chemical reactions. The mechanical collapsing of intramolecular bonds followed by a chemical changes takes place in mechanochemical synthesis. There are number of advantages of these reaction. It is eco-benign reaction because it can be performed at room temperature without using hazardous solvents, requires less time for reaction completion, normally 10-60 min, can lead to good yield, and small particles as a products are obtained.
- 3. Sonochemical Synthesis:** When high-energy ultrasound waves radiate on a reaction mixture, MOFs are fabricated through sonochemical synthesis. It has also numerous advantages like it is speedy, it provides adequate energy, it requires room temperature. The principal aim of sonochemical fabrication in MOF science was to find a rapid, energy-competent, eco-benign, room temperature approach that can easily performed. This is of unusual engrossment for their future utilities, since rapid reactions could boost the production of MOFs.

#### IV. APPLICATIONS OF MOF's

- 1. Mof's As Adsorbents:** MOFs are excellent substances for a future utility in the branch of pollutants separation from effluent through adsorption process due to the great penetrability of MOF and the unique interactivity in between adsorbate and adsorbent.
- 2. Adsorptive removal of toxic heavy metal ions from wastewater:** The toxic heavy metal ions include arsenic, copper, chromium, lead, mercury, nickel and zinc ions degrade the quality of water and which is dangerous to humans and other living species as well as ecosystem. These toxic heavy metal ions are removed from effluent using commercial adsorbents (e.g. zeolites and activated carbon materials) or some bioadsorbents such as modified coconut waste, modified sawdust or chitosan. In spite of all these adsorbents MOFs are also act as excellent adsorbents because of their unique properties.
- 3. Mofs AS PHOTOCATALYSTS :** It is observed that photodegradation is conceptually a good practice than adsorption for effluent analysis and treatment, because it causes a absolute removal of the toxic heavy meta ions or pollutants rather of its simple phase transfer, so no further analysis is required. The presence of organic connectors in MOFs are responsible for production of charge separated state which deteriorates in micorseconds which has wide spectrum of adsorption and thus permits in various photocatalytic utilities.
- 4. MOFs: Removal of organic pollutants by photocatalytically:** The photocatalytic deterioration of organic pollutants is a more rigorous method for water decontamination as compared to adsorption phenomena. For example, the in situ formation of highly reactive transient species (i.e.,  $H_2O_2$ , OH,  $O_2$ ) can change hazardous organic pollutants into harmless substances. In this view, latest reports suggest MOFs are new extraordinary materials as photocatalysts for the deterioration of organic pollutants present in effluent.
- 5. Removal of dyes by photocatalytically:** MOFs are able to show different photocatalytic properties beacause of the different electronic configuration of central metal atom present in MOFs.
- 6. Mof As Fluorescence Sensors :** The structure, composition and characteristics features of MOFs materials is responsible for showing the fluorecence property by MOF which is responsible for sensing of multivariant pollutants from effluent. Based on the penetrability of MOFs, there are different systems of guest@MOFs are synthesized. The dimension and configuration of the foreign substance and the voids of MOFs are some of the component that should favor for the fabrication of sensors. For the various purposed substances, specific MOFs-based substances need to be consider as fluorescence probes. It is important to notice the reciprocation to the encountered materials through such intuitive phenomena as fluorecence quenching of the MOFs-based materials. Therefore, each material may show different reciprocation mechanism depending upon type of sensor utilized. By replacing various organic ligands luminescence characteristics of MOFs can be strengthened. In the synthesis of MOFs various metal ions like lanthanide metals are also used.

- 7. Luminescence MOF's:** In latest years, LMOFs, as one of the most broadly used fields of MOFs, have expanded in the various branches like optical security displays, biomedical imaging and sensing, and illumination decoration due to their optical integrity and fluorescence heterogeneity, specifically in the area of harmful metal ions and toxic pollutants sensing. LMOF's has recent advances in sensing utilities of hazardous materials, with an attention on the impact of constitution or dimensions on the sensing abilities of LMOFs. Numerous luminescence sensing mechanisms and relationships between structure and performance are also concisely elaborated. Besides, the opinion and various pivotal issues of this field are also noted with the assumption of restoring more awareness on exploring the capabilities of LMOFs for sensing utilities.
- 8. Mof As Biomarkers:** Biomarkers are an indicator of biological consideration. The National Research Council (NRC) defines a "biomarker" as an indicator to consider the circumstance of a natural organization or sample, which can be assumed a device to scrutinize the correlation between touching outer chemicals and health lesions. The International Programme on Chemical Safety put forward a common explanation of biomarkers as a considerable indicator to consider the correlation between a natural organization and outer chemical, physical and natural constitute. As initial natural signals to indicate the harmful results of pollutants, biomarkers have been established and utilised by number of regulations to promote more and more concern. At present, the utilised sensing systems for biomarkers have concentrated mainly on all kinds of functional NPs and their nanocomposites. The selected NPs involve metal (Ag, Au, Pd, and Pt), oxide (ZnO, Fe<sub>3</sub>O<sub>4</sub>, CoFe<sub>2</sub>O<sub>4</sub>) and nonoxide species (CdTe) with unique optical, magnetic or electronic characteristics. These NPs frequently work as active constituents synthesized into host substances comprising MOFs. Some small molecules are also utilized for sensing biomarkers.
- 9. Mof In Oral Drug Delivery:** MOFs possess the special properties of systematically arranged structure and large surface area. Their tunable penetrability, chemical constitution, dimension and configuration simple superficial performance make this huge family more and more famous for drug delivery. Drugs can be implanted on the exterior surface, or covered into the porous structure.

MOF usage for therapies of various diseases: Because of their superior characteristics in drug delivery, MOFs have been utilized as a drug therapist for numerous diseases, including ocular diseases and tumors, lung disease, diabetes mellitus, infections which have made prominent progress in the previous some years.
- 10. Mof As Gas Storage:** MOFs are also well popularised for storage and separation of gas, because of their ultrahigh penetrability. It has high superficial area ranging from 100 to 10,000 m<sup>2</sup>/g, tunable penetrable size of 3 to 100 Å, high heat tolerance (up to 500 °C) and even exclusional chemical stability. The formulation of non-temporary penetrability for MOFs was realized in late 1990s, which initiated their utilities as adsorbents. The speedily latest records of penetrability and high superficial area highlights this kind of adsorbents very excellent option for gas storage and separation.

## V. MOF IN BIOMEDICAL APPLICATIONS

Because of the unique characteristics of MOFs, like their great penetrability, high superficial area, more aperture size & nanometer-scale size, they are widely used in biomedical applications. Natural macromolecules, like nucleic acids, proteins and peptides, attach to the superficial area of MOFs through coordination bonds, giving MOFs the capacity of target identification, analytical detection, drug delivery, biosensing, bioimaging, and biocatalysis. MOFs can hold biomolecules into their hollow aperture. They can be used as carriers for marking unique body sites and for command release of the drugs due to their extensive high superficial area (1000 to 10,000 m<sup>2</sup>/g), more penetrability. The size of the particle should be less than 200 nm so that these drug carriers are able to move freely. Different types of functional molecules can fit within the hollow aperture due to the high penetrability of MOFs and their adjustable aperture from microporous to mesoporous.

## VI. FUTURISTIC PERSPECTIVES OF MOF

The future of metal-organic frameworks (MOFs) is promising and exciting, with ongoing research and development expected to lead to numerous advancements and applications. Some of the key areas of focus and potential developments in the future include:

- 1. Improved Stability:** One of the significant challenges for MOFs is their stability in various environmental conditions. Future research is likely to concentrate on amplifying the stability of MOFs, making them more firm and suitable for practical applications, even in harsh conditions.
- 2. Tailored Functionality:** Researchers will continue to design and synthesize MOFs with tailored functionalities. By selecting specific metal ions and organic ligands, they can tune the properties of MOFs for numerous utilities, such as storage of gas, catalysis, drug delivery, and sensing.
- 3. Green and Sustainable MOFs:** As environmental concerns grow, there will be an emphasis on developing green and sustainable MOFs. This might involve using renewable and eco-friendly materials as building blocks for MOFs or developing synthesis methods that have a lower environmental impact.
- 4. Industrial Applications:** MOFs hold great potential for numerous industrial utilities, such as separation and storage of gas, and purification, as well as catalysis and chemical reactions. In the future, we can expect to see MOFs being implemented on a larger scale in industrial processes to improve efficiency and sustainability.
- 5. Energy Storage:** MOFs with high surface areas and tunable porosity could play a crucial role in energy storage technologies. They might be used for advanced battery materials, supercapacitors, or as storage media for hydrogen and other energy carriers.
- 6. Water Harvesting and Purification:** MOFs have shown promise in capturing and releasing water molecules from the atmosphere, which could have significant implications for water harvesting in arid regions. Additionally, MOFs' ability to

selectively adsorb specific molecules makes them suitable for water purification and desalination processes.

7. **MOFs in Medicine:** In the medical field, MOFs could find applications in targeted drug delivery systems, imaging agents, and theranostics (combined therapy and diagnostics). MOFs might enable more efficient and controlled drug release, minimizing side effects and improving treatment outcomes.
8. **MOFs in Electronics and Optoelectronics:** MOFs with semiconducting or luminescent properties could be integrated into electronic devices and optoelectronic applications, such as sensors, light-emitting diodes (LEDs), and photodetectors.
9. **Artificial Photosynthesis:** MOFs may play a role in developing artificial photosynthesis systems that convert carbon dioxide and water into useful chemicals and fuels using solar energy. These systems could contribute to addressing climate change and energy sustainability.
10. **Space Exploration:** MOFs could have applications in space missions, such as gas storage for propulsion systems or as protective materials for sensitive instruments.

## VII. COVALENT ORGANIC FRAMEWORKS(COFS)

Covalent organic frameworks (COFs) are a group of matter which form two or three proportional shapes and dimensions. Organic precursors are going to react to form strong & covalent bonds which results into a penetrable, steady and translucent matter. COFs emerged as a field from the overarching field of organic materials as scientists optimized both man-made control and predecessor choice. These enhancement in coordination chemistry enable non-penetrable and shapeless organic matter such as organic polymers to proceed into the synthesis of penetrable, translucent matter with definite structures that shows exceptional matter firmness in a broad spectrum of solvents and conditions. Through the growth of reticular chemistry, accurate manmade command was performed and consequence in controlled, nano-penetrable shapes and dimensions with greatly proclivity of structural orientation and characteristics which could be synergistically strengthened and intensified. With sensible choice of COF secondary building units (SBUs), or predecessor, the last shape and dimension could be predestined, and remolded with unusual dominance authorizing fine-tuning of disclosure characteristics. This rank of dominance enables the COF material to be sketch, fabrication, and applied in numerous fields.

The fabrication of 3D COFs has been hampered by time honoured applicable and theoretical summons up till it was first attained in 2007 by Omar M. Yaghi and colleagues. Unlike 0D and 1D systems, which are soluble, the insolubility of 2D and 3D structures prevent the utilization of cumulative fabrication, making their separation in translucent form very burdensome. This first provocation, however, was overcome by sensibly selecting building block materials and utilising reversible condensation reactions to crystallize COFs.

## VIII. RETICULAR FABRICATION

Reticular fabrication facilitates bottom-up fabrication of the skeleton matter to establish accurate disruption in chemical constitution, consequencing in the highly disciplined tunability and characteristics of substructure. Through a bottom-up fabrication, a matter is composed from atomic or molecular constituents artificially as against to a top-down fabrication, which forms a matter from the bulk through various paths such as exfoliation, lithography, or other ways of post-artificial alterations. The bottom-up fabrication is especially benefitted with respect to matters such as COFs due to the unnatural ways are fabricated in such a way that they directly outcome in an prolonged, exceptionally interlinked substructure that can be tuned with unusual command at the nanoscale position. Geometrical and dimensional assumptions conduct the substructure resulting topology as the SBUs merge to produce predetermined shapes and dimensions. This position of artificial command has also been defined "molecular engineering", & this term was defined by Arthur R. von Hippel in 1956.

COF topological command through sensible choice of predecessor that consequence in bonding directionality in the final resulting framework.

It has been accepted in the literature that, when combined into an isorecticular substructure, such as COF, characteristics from monomeric substances can be mutually intensified and strengthened. COF matter exhibits special property for bottom-up reticular fabrication to afford strong, tunable substructure that artificially amplified the characteristics of the predecessor, which, in turn, offers many benefits in terms of advanced performance in various implementations. As a result, the COF structure is greatly modular and tuned efficacious by replacing the SBUs' identity, length, and functionality depending on the required characteristics change on the substructure rank. There exists the capability to introduce various functionality directly into the substructure scaffold to permit for a various functions which would be unmanageable, if impossible, to fulfill through a top-down approach such as lithographic method or chemical-based nanosynthesis. Through reticular fabrication, it is achievable to molecularly engineer modular, substructure matter with highly penetrable scaffolds that display special electronic, optical, and magnetic characteristics while simultaneously embedding required functionality into the COF framework.

Reticular fabrication is dissimilar from retro fabrication of organic compounds, because the structural purity and firmness of the building block materials in reticular fabrication remain unchanged throughout the synthesis procedure—an critical feature that could help to fully recognize the advantages of architecture in translucent solid-state skeletons. Similarly, reticular fabrication should be differentiated from supramolecular congregation, because in the former, building block materials are interconnected by strong bonds throughout the crystalline framework.

**Artificial Chemistry:** Reticular fabrication was utilized by Yaghi and coworkers in 2005 to fabricate the first two COFs reported in the literature: COF-1, using a dehydration reaction of benzenediboronic acid (BDDBA), and COF-5, via a condensation reaction between hexahydroxytriphenylene (HHTP) and BDDBA. These substructures were linked through the

synthesis of boroxine and boronate connectivities, respectively, using solvothermal manmade processes.

## IX. APPLICATIONS OF COF

- 1. Gas storage and separation:** COFs can be designed with specific pore sizes and geometries, making them promising materials for storage and separation of gas applications. They can adsorb and store gases like hydrogen, methane, carbon dioxide, and other environmentally relevant gases.
- 2. Catalysis:** COFs can act as efficient catalysts in various chemical reactions due to their well-defined and accessible active sites. They can catalyze reactions such as hydrogenation, oxidation, and carbon-carbon bond formation.
- 3. Sensing:** The structural flexibility and porosity of COFs allow them to interact with specific analytes, making them suitable for gas sensing and chemical sensing applications.
- 4. Optoelectronics:** COFs with  $\pi$ -conjugated structures can exhibit interesting electronic and optical properties, making them potential candidates for optoelectronic devices such as light-emitting diodes (LEDs) and photodetectors.
- 5. Energy storage:** COFs have shown promise in energy storage applications, particularly in supercapacitors. Their broad superficial area and adjustable aperture size can enhance the charge storage capacity.
- 6. Drug delivery:** The porous nature of COFs permits for the encapsulation and controlled release of drugs and other bioactive compounds, making them useful for drug delivery systems.
- 7. Environmental remediation:** COFs can be functionalized to selectively capture and remove pollutants from water and air, aiding in environmental remediation efforts.
- 8. Membrane technology:** COFs can be integrated into membranes to achieve selective separation of molecules in processes such as water purification and gas separation.
- 9. Flexible electronics:** The mechanical flexibility of certain COFs can be utilized to synthesize flexible and stretchable electronic devices.
- 10. Nanotechnology:** COFs can serve as building blocks for nanoscale devices and materials due to their precise structures and well-defined functionalities.

## X. CONCLUSION AND PERSPECTIVE

Coordination chemistry is a fast growing field of chemistry which includes , metal–organic frameworks (MOFs) and covalent organic frameworks(COFs) with adjustable

penetrable structures, dimensions and configurations and number of active locations have confirmed to be absolute material for numerous utilities. As a promising group of translucent penetrable inorganic–organic composite matter, MOFs and COFs can primarily assimilate almost limitless various functional constituents including metal ions, organic ligands and guest molecules/ions. More significantly, their penetrable shape, dimension and configuration and chemical surroundings within a hollow aperture are greatly exchangeable and can be changed by following reticular chemistry.

## **XI. STATE OF THE ART**

MOFs and COFs are fabricated from these association between the metal ions and bridging organic ligands. These materials are famous among latest studied cheap adsorbents or sensors because of many fascinating characteristics. Penetrable 3D network with broad superficial area, adjustable aperture size, more firmness, low-cost fabrication, more efficiency and simple isolation made MOFs and COFs makes guarantee in succeeding age matter in various fields. Regardless their benefits, certain MOFs and COFs shows poor characteristics, including poor water firmness and lower thermostability than other materials. To recompense for these inadequacy, a controlled integration of various MOFs/ COFs and building matters are being explored to establish excellent multifunctional units with effective characteristics facilitated through the mutual effects of the individual units. MOFs/COFs are glazed on numerous membranes to amplify their functionality. Some binary and higher composites are also derived from organic materials like chitosan, dendrimers, cyclodextrin and inorganic frameworks like LDH, zeolites and made certain hybrid materials e.g., binary composites like (cyclodextrin-MOF), (chitosan-MOF), (LDH-MOF), ( $V_2O_5$ -MOF), (LDH- $V_2O_5$ ) and ternary composites (MOF-chitosan-cyclodextrin). These synthesized binary and/or any other higher constitutional composites are aimed to be employed for sensing or adsorption of multivariant pollutants like heavy metal ions, POP's (dioxins), organic insecticides and pesticides. es,  $V_2O_5$  and many more applications.

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